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Water Supply Legislation at Albany.

It is perhaps only natural that the present session of the Legislature of the State of New York should be used as an opportunity for attempts to obstruct or defeat the efforts of the City of New York to obtain an additional water supply. It is alleged that a large part, and in all probability by far the greater part, of the opposition to the present plans of the city to take water from the Catskill regions, which was developed at the recent session of the State Water Commission at Kingston, was designed to place the parties in interest in the most advantageous position possible for securing large damages from the city rather than a genuine opposition to that plan. Without doubt there were some sincere and earnest opponents to the proposed plans in the belief that it would be better for the communities affected to remain undisturbed. Probably the great majority of the opposition, however, would be much disappointed should the City of New York abandon its plans and so fail to disburse the enormous sums which would be expended in those communities in the execution of the work. All this is natural enough and no serious fault can be found with such features of an enterprise of this character. The case, however, is different with those parties who have introduced bills at this session of the Legislature for the purpose of obstructing the City of New York in carrying out its plans for securing an imperatively needed additional supply of wholesome water. The most recent bill of this character would prevent the city from entering Ulster County precisely as the so-called Smith law has prevented the city from taking water on the easterly side of the Hudson. Such legislation is uncalled for and should not receive support in the Legislature nor the sanction of the governor of the State.

This whole question of the propriety or equity of a great city seeking its water supply in any portion of the State was abundantly discussed at the last session of the Legislature. All the features of such projects, both for and against, were analyzed and subjected to an unusually critical consideration. It was recognized that the unaided smaller communities in country districts might be subject to some injustice by powerful municipal corporations seeking water supplies and taking from them water rights to which they justly held title not only under law but by what may be termed a common or natural right due to location and long periods of undisturbed usage. On the other hand the imperative necessities of great communities must be recognized. Cities possess the right to exist and they are entitled to reasonable opportunities to satisfy their legitimate needs. They are parts and essential parts of the State, as well as the smallest hamlets of the country. While it is true that the latter must not be subjected to injustice, it is equally true that the actual needs of the former must be supplied.

In order that the rights of the smaller communities on the one hand might be protected and the just requirements of the large cities be met on the other, in other words, in order that there should be preserved perfect justice between the two sets of parties in interest, the State Water Commission was created by act of the last Legislature to take into consideration every water supply project and to permit its execution only under such conditions as would be just and equitable to everybody concerned. It was made the duty of this commission to hold public hearings in the most open and unconditional manner so that every interest affected, small as well as large, should have an opportunity to set forth its case and secure complete protection in every respect. No law could have a fairer purpose, and it is not easy to imagine any more effective method of protecting every well-founded right.

This State Commission is certainly performing its duty in a broad and comprehensive manner. While it has as yet rendered no decision in connection with the proposed plan of additional water supply for the City of New York, it has held many hearings and has taken a much longer time for the consideration of this project than at first anybody supposed would be necessary. If therefore, any criticism whatever can be made of its course it would lie in subjecting the City of New York to unnecessary delay and not on the ground of ignoring local interests. So far as can be seen, it would appear that the Commission is giving careful and well considered attention to every feature of its business. At any rate it is far too soon practically to assume that it is about to fail in its purpose.

There is no ground whatever on which such special legislation as that considered can be justified except the failure of the present State Commission to perform its duty, and there is certainly no reason up to the present time to make such a charge. These moves of special legislation are so vicious in general principle that they never accomplish unmixed good. At best they are makeshifts, which carry evil in their train even when some of the ends attained are desirable. The City of New York has its rights as a part of the great community of the State to the surplus waters of the Catskills as well as to those of Dutchess and Suffolk Counties, and it would be most desirable even at the present time to repeal all obstructive legislation of that character rather than to enact more. If these special bills now pending at Albany should be enacted into law it would be a practical condemnation of the present State Water Commission and in essence a rejection of the legislation which created it. The procedure by which the City of New York is now endeavoring to secure more water, essential not only to its welfare but to its actual life, has been established by statute after a most thorough and comprehensive consideration of all the interests involved, and it should not be put to utter confusion, with indefinite demoralization and delay, under conditions where efficiency and promptness in relief to the city are absolutely imperative.

Buying on Brand.

The paper by Mr. Meade on the selection of cement for concrete building blocks, which is printed elsewhere in this issue, brings up again the desirability of testing standard materials purchased in small quantities. This is a serious matter in some cases, for the expense and delay incident to making the tests may more than counterbalance the extra cost of purchasing the materials from some maker whose reputation is a guaranty that only good products leave his works. The problem that faces the purchaser is whether to call for bids from everybody and trust to the enforcement of specifications to assure the delivery of good materials, or to restrict the competition to those makers whose brand is a guaranty equal to the favorable report of a testing laboratory.

There is a large amount of work for which material of inferior character is adequate. Poor steel is used up in the mills for their own purposes without the slightest apprehension as to its usefulness, while The Engineering Record has seen at two cement plants good-looking concrete buildings constructed exclusively of cement rejected by fastidious customers. As a matter of fact, probably half the steel and cement purchased in this country is delivered under specifications calling for a grade of material far better than the character of its use warrants. The specifications for this grade might not be fulfilled and yet the material would be entirely satisfactory for many purposes. No good mill will let unsound material leave its premises, yet it is equally certain that most mills like to give a customer what he needs rather than what is called for by the specifications he has copied from those of some other work.

Very few people really know how to prepare specifications properly; indeed, they are considered beneath the dignity of some engineers and architects of the old school. It is for this reason that so much good is to be expected from the standard specifications of the American Society for Testing Materials and the American Railway Engineering & Maintenance of Way Association. These indicate to manufacturers the standards to which their products must conform and thus do away with the great variety of requirements which retard the attainment of a few uniformly good products at a reasonable price. The standard specifications for steel and cement have been of the greatest importance on this account, advancing equally the interests of the manufacturer and purchaser.

Since the introduction of these standard specifications the problem of purchasing small quantities of materials like steel and cement has been much simplified. Most mills can furnish them from stock on receipt of the order, and if the purchase is made from a reputable concern and the material is to be employed under ordinary conditions it is probably a waste of time and money to test it. If the work is important, then the material should be tested, no matter how small the quantity purchased, but there is no more reason for testing every little lot of cement or beams than there is for testing the small quantity of rods and bars used in the average machine shop. It is necessary to trust a good many people in order to accomplish anything in manufacturing or commerce, and the problem is simply one of relying only on responsible people.

The concrete block industry is one of those where testing may or may not be desirable, depending wholly on its extent. A large yard might find it desirable to purchase considerable quantities of cement at one time, and to test it; by so doing competition might be widened and lower prices secured without any sacrifice of quality. A small testing equipment is not expensive and the manipulation of the tests which suffice for determining the suitability of most cements is not difficult, although somewhat tedious. The tests might also be made by a commercial laboratory. Most concrete block yards are not large enough, however, to carry on testing and, like the machine shops, will find it desirable to buy their supplies on brand rather than on elaborate specifications. There is very little cement made to-day in the United States that is not good for concrete blocks.

The Cape Cod Canal.

The announcement made a few days ago that all preliminary steps had been taken to ensure the construction of a canal across Cape Cod, from Buzzard's Bay to Barnstable Bay, is a little ahead of the season. Usually it comes somewhat later in the year, about the time the sap begins to start in the trees and people give a few thoughts toward their summer outings. Rumors about the ship canal work are an ever interesting method of attracting attention to the Cape, the playground of New England, just as Long Island is the playground of New York. Although it is an old story, it is as serviceable now as in 1676, when it first appeared to take an honored place in perennial literature, along with spring poems and sea serpent stories. It became a theme of such interest before the colonists had done much more than string their settlements along the clam-laden shores of Massachusetts Bay that they discussed in their General Court, in 1697, the advisability of undertaking the work. Unfortunately the matter fell into the hands of a legislative committee, which, in the usual way, fell asleep over the subject for about seventy years. Meanwhile private parties had not lost their interest in the project, however, and just before the Declaration of Independence was signed a public surveyor had been put to work examining the route of the canal. The conflict with the mother country and the building up of a workable system of government stopped all consideration of the project for some years, but about 1824 it appeared again, this time in Congress, where nothing was done further than discuss the subject. In 1860 it was again before Congress and its chances of favorable action seemed bright until they were smothered for the second time by the approach of war. About fifteen years later another plan for the work was talked about, this time one which did not require any locks, and ten years later, about 1885, some excavation was actually commenced, which came to a stop after something over a mile of canal had been constructed.

This long record will indicate that back of the talking and joking about the Cape Cod canal there must be some measure of merit. What it is can be understood by a glance at a map of Eastern Massachusetts. It will be seen that vessels plying between New York and Boston are compelled to make a long trip past Martha's Vineyard, Nantucket and Cape Cod, and are exposed for a part of the voyage to whatever storms sweep over that part of the Atlantic. Buzzard's Bay is a long inlet reaching almost across the southeastern part of the commonwealth up to Cape Cod Bay. The strip of land separating the two bays contains a sluggish stream, the Monument River, which is reported to have been large enough in early colonial days to permit navigation almost across the neck. Like many of the other things of the good old days it has sadly diminished in its extent, however, or else the old records exaggerate the original conditions, for considerable excavation will be needed to make a canal able to accommodate the vessels now sailing between the two ports. There can be no question, however, that a canal can be constructed without any engineering difficulties at this place, and the only thing to be considered about the undertaking is its commercial advisability.

The Engineering Record has long held that a Cape Cod canal would be a good business venture provided it had the backing of the marine department of the New York, New Haven & Hartford R. R. Co. That company handles an enormous freight and passenger business between New York and Boston by way of the Fall River and Providence steamboats. The Providence boats also handle freight and passengers for points in New England reached by railroad connections not passing through Boston, but the Fall River line is essentially a Boston service. It is probably the finest steamboat service in the United States and its weak point is the necessity of breaking it at Fall River, for the train ride to Boston. The construction of the Cape Cod ship canal will enable boats to sail directly between Boston and New York in about the same time that is consumed by the combined sea and land trip now. It may be said without fear of contradiction that the all-water trip between Boston and New York would add to the travel very materially, and enable the company to alter its train service between Fall River and Boston, which cannot now be satisfactory from an operating point of view.

The ship canal will also be of service to a considerable shipping interest, for it will shorten the sailing distance between New York and Boston about 70 miles as compared with the "inside" route and 142 miles as compared with the "outside" route between the two places. At present about 40,000 vessels round the Cape annually. During about 100 days in the year fog makes the inside route impracticable, while the storms off the Cape at certain seasons of the year are a serious drawback to shipping. The canal route is largely inland and not exposed to more than normal interruptions from fogs. It will make necessary considerable improvement work in the two bays, but the commerce to be handled will justify the Federal Government in carrying these out. It is estimated that the work on the canal proper will cost about $6,000,000 and will take about two and a half years for its completion. It is a project that should prove successful if supported by the owners of the great steamboat lines terminating in Narragansett Bay at present.

Engineering Professors.

At a recent convention of the American Association for the Advancement of Science, Prof. D. S. Jacobus of Stevens Institute, presented a paper on investigations and commercial tests in connection with the work of an engineering college that was thoroughly in line with the statements made in this journal last week. The full text of this paper, which formed the chairman's address before the Section of Mechanical Science and Engineering at the convention, has been printed in "Science" of Jan. 19, and will be found one of the most conservative discussions of the status of the engineering professor which has yet appeared. The axiom with which the paper opens is that, "in technical schools, those who teach the practical engineering subjects cannot speak with authority unless they have had practical experience." Farther along in the paper is a statement which this journal considers equally important, "the one proper way to teach an engineering subject is for the professor at the head of a department to get down to hard work with his students, and to know each of them so well that he is thoroughly acquainted with their personal characteristics." This second statement is one that deserves consideration in discussing the general subject of qualifications for teaching engineering. Unless it is kept in mind there may be some danger of a professor being regarded as little more than an eminent engineer who occasionally delivers a lecture before his students, while the actual instruction is left to young assistants. The safe course, which will bring the maximum good to the students and at the same time enable the schools to keep men of distinction on the faculties, is to consider the latter in the same light as the chief engineers of large enterprises, making them responsible for results but freeing their hands of the detail that others can do as well. These eminent men will furnish the inspiration which every student needs, they will watch his work and will teach those subjects where breadth of view and the weight of authoritative statement are essential to satisfactory instruction. They must be given good assistants, of course, to make this plan successful. It is useless to expect all instructors to be men of high standing as practicing engineers, but it is reasonable to demand that the instruction in each subject shall be given by a man qualified as an expert on it.

The most interesting part of Prof. Jacobus' paper is his discussion of the ways in which an engineering professor may acquire the practical experience necessary in his work. Three methods are suggested: first he may be called to the professorship from the practical field; second, after teaching for a time he may turn to practical work until he has acquired the desired experience, and may then return to teaching; third, he may carry on practical work in connection with his college duties.

The first method seems hardly calculated to furnish good teachers unless from a class which has an inherent love of such work. By the time an engineer has acquired mature experience in practice he is so old that it may be difficult for him to teach satisfactorily. It does not follow because a man knows a subject that he can teach it; in fact, some of the great authorities are the poorest teachers. Nobody can impart the combination of sound theory and lessons from practice which ought to be given in engineering courses who is not a really good instructor; a few men may be born, like poets, with the gift of lucid statement, but most of us have to be trained for a long time before acquiring a concise and clear use of words. In short, teaching has to be learned like any other calling. The practicing engineer who takes up teaching, therefore, must not only give up work which is generally more remunerative than teaching but must also prepare himself at considerable labor for his new task.

The second method of acquiring practical work, of sandwiching in a year or so of practice between several years of teaching, is apparently that advocated by the Cornell authorities. It has two disadvantages, however, for the teacher may find his practical work so attractive and lucrative that teaching will be given up, and, on the other hand, a teacher advanced in years may find it difficult to secure a position which the dignity of his college position will warrant him in accepting.

The third method of acquiring practical experience is to carry on independent engineering practice in connection with regular class work. No professor with many classes can do much of this outside work without neglecting his students. "If he is an enthusiast," Prof. Jacobus says, "he will find that he must often stand up to his task night after night, and unless he is willing to do this it is folly for him to undertake to gain experience in the way indicated." While it is not directly stated in the paper, it is apparent that Prof. Jacobus believes a professor doing good practical or research work brings so much credit to his college that it is sound business for the college to permit him to spend a considerable part of his time in this way. Of course, no professor should be permitted to endorse proprietary compounds or lend the school's name in any way to tests which will be of more use to the salesman of apparatus than to the members of the engineering profession. There is also great danger of a professor bringing discredit upon his college if he is careless in his testimony as an expert witness. In the care of anybody really qualified for the position of professor in an engineering school, however, the reputation of the college will be secure. Certainly Stevens Institute has gained standing from the connection of Prof. Jacobus with it, yet he frankly states that much of the work undertaken in connection with his college duties has been done for consulting experts. The day is past, he rightly states, when there can be a strict line drawn between the work of the consulting engineer and that of the professor who teaches in the same field.

Notes and Comments.

An Automobile Testing Plant has been installed at Purdue University, which will enable tests to be made of both pleasure and commercial cars. It is of the traction dynamometer type, similar in principle to that of the Purdue locomotive testing plant.

Steam Turbine Plants have been designed for Fort Wayne, Ind., and Hamilton, O., in which the boilers are on the ground floor and the turbines on the floor above. This makes the steam and exhaust piping short and direct. The exciters are on the generator shafts.

Acetylene Gas for welding steel and iron has been used with success in Italy, the resultant heats considerably exceeding those of the oxyhydrogen flame. The gas is mixed with air in the burner in a manner similar to that used for the oxyhydrogen flame.

A 750-ton Hopper Dredge has been built for deepening the Newport, Monmouthshire, harbor and approaches, which will excavate to a maximum depth of 48 ft. below water level, and has a nominal capacity of lifting 900 tons of material per hour. It has two sets of triple-expansion surface-condensing engines of sufficient power to drive the boat at a speed of 9 miles per hour, and gearing is provided enabling either engine to drive the dredging gear at varying speeds for working on hard or soft material.

A Trolley Boat has been in service during the winter in the intake canal of the Niagara Falls Power Co. for keeping the surface free from floating ice. The boat is 25 ft. in length by 10 ft. beam and is operated by a 75-kw Westinghouse single-phase railway motor, current being delivered to the boat by double trolley wires suspended longitudinally over the canal with overrunning trolley and flexible cable. The motor has rheostatic control giving a range of propeller speeds of 100 to 275 r.p.m. The boat is used to break up the ice and drive it toward the overflow near the head house.

The Recovery of Baltimore from the effect of the fire two years ago has been astonishing. The area covered by the burned buildings was 2,300,000 sq. ft., of which 335,000 sq. ft. were taken for street widenings by the Burnt District Commission, leaving 2,045,000 sq. ft. available for building operations. The amount now rebuilt is 1,477,000 sq. ft., or 72 per cent. The total floor space in the district was 8,534,000 sq. ft., exclusive of the part appropriated for public purposes, whereas it is now 6,613,000 sq. ft., or 79 per cent. of the former amount. The value of the new buildings is estimated at about $20,000,000, and over half of them are now ready for use.

A Bearing Metal should have, according to Prof. R. C. Carpenter, a considerable adhesion to a lubricant and be readily wet by it, should be softer than the shaft so that it will be injured instead of the shaft in case of grit in the bearing or a failure to maintain lubrication, should be hard enough to keep its shape under any loads that are likely to come on it, should have a melting temperature less than that of the journal, and should not adhere to the shaft when melted. For ordinary purposes, Prof. Carpenter recommends babbitt metal, but for more severe conditions he advises a mixture of 50 per cent. of aluminum, 25 per cent. of zinc and 25 per cent. of tin.

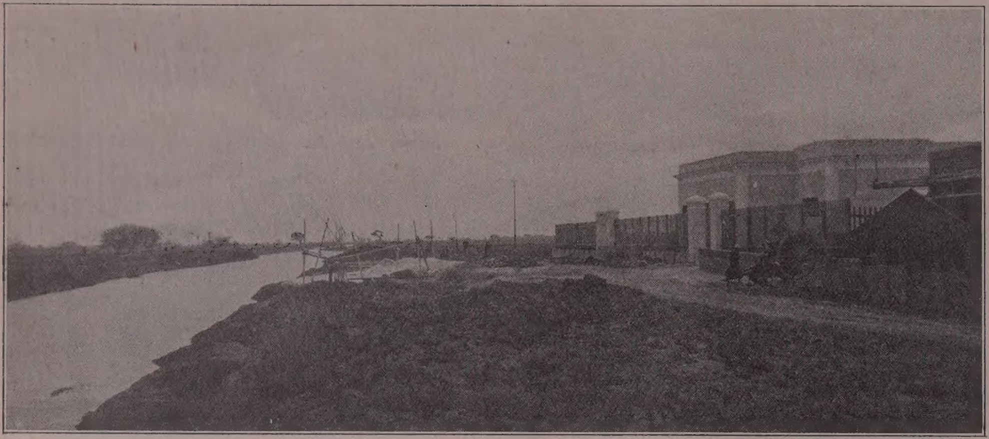
The Maintenance of Electrical Apparatus is threatened by a bill introduced in the New York Legislature. It provides for the registration of "master electricians" and prohibits not only original installations, but also alterations and repairs to wires, apparatus and appliances for light, heat and power, except they are made by this new class of privileged characters. The owners of hotels, industrial establishments and office buildings who employ competent electricians would be prevented, under the terms of this act, from having their own work done by their own men. This would create such annoyance and needless expense that there should be immediate action to prevent the passage of the bill.

A Septic Tank Explosion occurred at the sewage disposal works of Saratoga Springs, N. Y., on Jan. 26. The entire concrete top of one of the 91x51-ft. tanks (see Eng. Record, Jan. 21, 1905) was blown up several feet and fell back into the tank; the walls were apparently not injured. Such explosions have occurred a number of times in British septic tanks, but this is the first case in the United States that has come to the attention of this journal. That the gases which are given off from septic sewage are likely to cause explosions was pointed out several years ago by Mr. Harrison P. Eddy, superintendent of sewers of Worcester, Mass. Some investigations he made in association with Prof. L. P. Kinnicutt, reviewed in this journal on May 16, 1903, showed that septic sewage at Worcester gave off a gas containing 75 per cent. of marsh gas, 6 per cent. of carbon dioxide and 19 per cent. of nitrogen. The amount of the gas varied from ¼ to 1 cu. ft. per 100 gal. of sewage passing through the tank, being greatest in warm weather.

The Civil Service Examination for engineers for the New York Board of Water Supply had one important result. About 800 men asked for information about the examination and 522 filed applications to be permitted to take part. Although the candidates were of unusually high quality, only 19 passed the examination for the highest grade, 47 that for the middle grade and 131 that for the lowest grade. The questions were printed in this journal on Feb. 3, and were fair tests of a candidate's knowledge and common sense. A treatise could be written on some of them, but the candidate's sense of the fitness of things will be shown by his answers to such questions, which can be satisfied by a condensed sketch of the whole subject or by detailed notes of each part of it. Some first-class men failed to pass the examination and some undesirable candidates were successful, but the fact of all others that stands out most prominently is the inability of three-quarters of the technical school graduates who took the examination to pass the lowest grade.

The Erie R. R. Electrical Commission has been appointed and will begin its studies immediately. It has been known for a long time that the Erie R. R. has been studying the possibilities of electric traction for its suburban service in the neighborhood of New York City, but the equipment of these lines has been delayed for a number of reasons. The directors of the company have recently authorized Vice-President J. M. Graham to organize an electrical commission to study the subject in detail and it is thought that one of the branch lines, either the Northern Railroad of New Jersey or the Greenwood Lake Division, will be equipped with electricity within the next year. The electrical commission, which was appointed Feb. 2, consists of Messrs. J. M. Graham, vice-president, chairman; Bion J. Arnold, L. B. Stillwell, E. A. Williams, general mechanical superintendent; A. J. Stone, assistant general manager; C. H. Morrison, acting electrical engineer and secretary of the commission. The commission will make a study of the proper system to be adopted and will report to the directors.

The Labor Conditions on the Panama Canal were discussed with forceful freedom by Mr. Shonts in his address last month before the Commercial Club, of Ohio. He pointed out that very few American unskilled laborers will find employment on the canal work, for there is a much better opportunity for them at home. Four-fifths of the common laborers will be aliens, to whom the eight-hour law is an entirely unknown measure when they reach the Isthmus. The enforcement of the law in their behalf will increase the cost of canal construction at least 25 per cent. for the sole benefit of foreigners. The skilled American workmen on the Isthmus prefer the ten-hour day, Mr. Shonts says, and, in fact, many of them have asked for it. Another fact mentioned in this address adds to the strength of the argument for excluding the Isthmus from the application of the eight-hour law, the contract labor law, the Chinese exclusion act and all other laws for the benefit of American labor in the United States. This is the fact that a large part of the work will be done by contract. It is proposed to divide the construction into sections and let contracts for such of them as can be handled advantageously in that way. Private contractors will be able to accomplish much more work and thus push ahead the date of completion of the canal if they are not hampered by labor restrictions of no benefit to American workmen.



The Water Filtration Plant on the Canal at Mansourah, Egypt.

THE AMERICAN SYSTEM OF FILTRATION AT MANSOURAH, EGYPT.

By Edmund B. Weston, M. Am. Soc. C. E., M. Inst. C. E., Consulting Engineer, Providence, R. I.

Mansourah is a town of Lower Egypt on the Damietta branch of the River Nile, about 35 miles southwest of Damietta and 68 miles northeast of Cairo. The population is about 27,000. Mansourah was founded in 1220, and St. Louis (King Louis IX) of France during his first crusade, after the disastrous defeat and capture of his army before the place by the Mussulmans, was imprisoned there for a short time in 1250.

The filter plant purifies the water supply of Mansourah and has a capacity of 1,300,000 U. S. gal. per 24 hours. The raw water flows from the River Nile to the intake of the filter plant, through a canal. The plant consists of a building containing three 15-ft. steel filters of the Jewell gravity type, a filtered water well, one low-lift pump driven by an oil engine for raising the water from the canal to the subsidence basins, three high-lift pumps driven by oil engines, and having a capacity of 450,000 U. S. gal. per 24 hours each for pumping the filtered water from the filtered water well through a force main to a standpipe, and three masonry coagulation and subsidence basins, each allowing a period of coagulation and subsidence of about three hours. The water flows by gravity from the subsidence basins to the filters. The oil engine which drives the low-lift pump also drives the line shafting which operates the agitators when the filter-beds are being washed.

About one-half of the filter building comprises a filter room in which the filters and their auxiliaries are located; the remaining portion of the building is occupied by the pump combinations and by a store-room and offices.

Sulphate of alumina is the coagulant used in the purification of the water. The coagulant is fed to the raw water by gravity, one end of the filter room being built high enough for the purpose.

The filter-beds are washed with filtered water, which is supplied under pressure from the force main through which the filtered water is pumped to the standpipe.

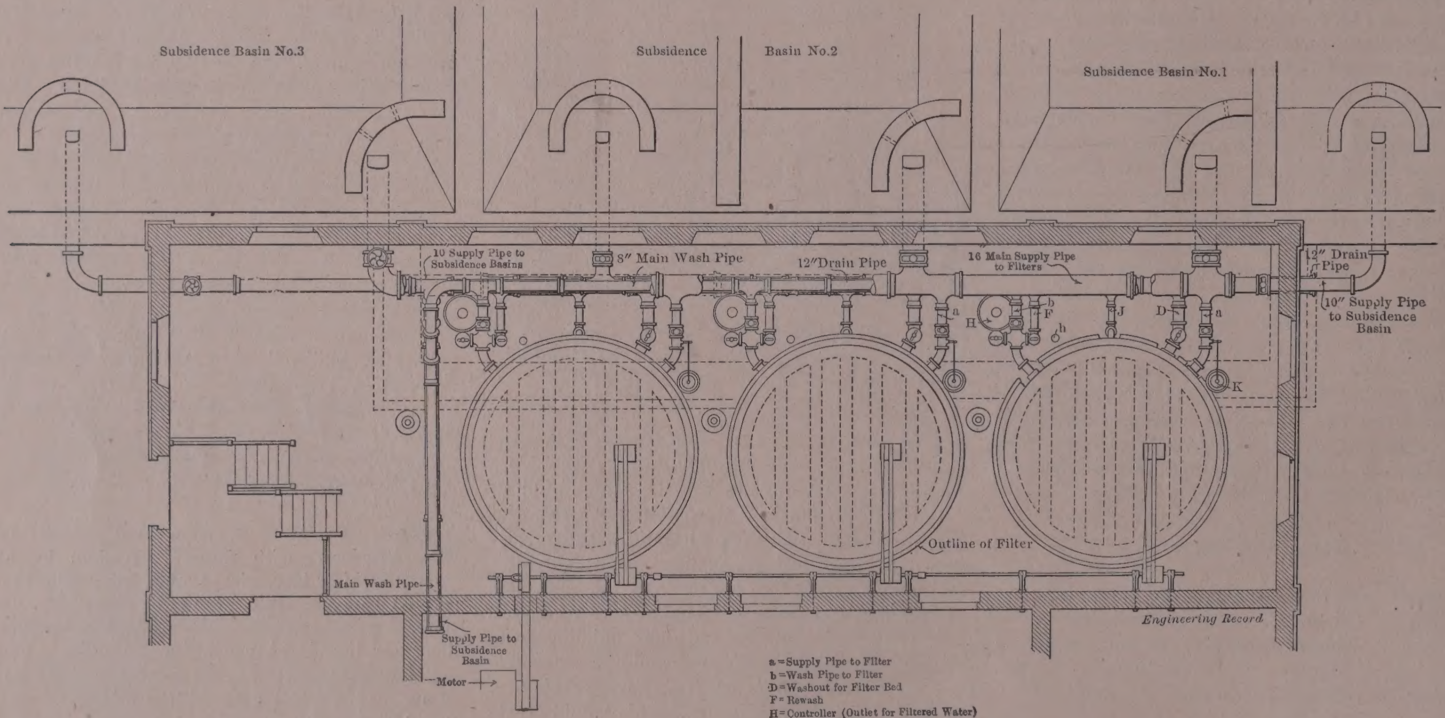
The Jewell Export Filter Co. furnished and erected the filters and their auxiliaries, under contract with the municipality of Mansourah. The remainder of the filter plant, including the filter building, filtered water well, coagulation and subsidence basins and pump combinations, was contracted for with other parties by the municipality of Mansourah.

It was the intention in the first place to install but two filters, although the filter building was built of sufficient size for three filters, and the work at first was carried out with this intent and only two filters were installed and two coagulation and subsidence basins built. Shortly, however, before the first two filters were completed, it was decided to put in a third filter, and a second contract was made with the Jewell Export Filter Co. for furnishing and erecting the filter and its auxiliaries and a third coagulation and subsidence basin was also built. The first two filters went into service in April, 1905, and the third filter in July, 1905.

Recent advices from Egypt state that the filter plant is giving excellent satisfaction. The methods of water purification in Egypt have to be sanctioned by the government, and as additional evidence that the Mansourah filter plant is highly appreciated in Egypt, it may be stated that the municipality of Damietta, Egypt, with the sanction of the government, made a contract with the Jewell Export Filter Co. in November, 1905, for furnishing filters and auxiliaries of the same capacity and design as at Mansourah, for a filter plant which is now in course of erection at Damietta.

The writer has not lately received any official results regarding the purification of the water at Mansourah, although during the official test it exceeded the contract guarantees, but the following extract from a report, dated July 11, 1905, of the Chief Engineer and of the Sanitary Inspector of the City of Alexandria, Egypt, relative to the purification of the Nile water by the large filter plant at Alexandria, the filters and their auxiliaries of which were furnished and erected by the Jewell Export Filter Co., gives an idea of the high degree of purification obtained at Alexandria:

"In the case of the bacterial efficiency of the new filters, from numerous analyses which have been made personally by the Sanitary Inspector and his assistant, Dr. Delta, it is especially shown that the removal of the microbes from the raw water by the process of subsidence and filtration has always been very satisfactory. Even during the most difficult periods of filtration, when the



a = Supply Pipe to Filter
b = Wash Pipe to Filter
D = Washout for Filter Bed
F = Rewash
H = Controller (Outlet for Filtered Water)
h = Loss of Head Gauge
J = Overflow Pipe
K = Float for regulating Supply

Plan of Filters and Connections.

efficiency was at its worst, that is to say during the first half hour after the washing of the filters, it was never below 99 per cent. It takes but five minutes to wash a filter, and yet within fifteen to twenty minutes after the commencement of a new period of work the filter again acquires its normal efficiency. It should be especially noted that the filters have worked during the last weeks under very difficult conditions owing to the presence of numerous algae in the raw water (season of green water); notwithstanding this, the results of filtration continued to be satisfactory. To cite but one example, the number of bacteria (always entirely harmless) in the filtered water was on July 8 but 22 per cc. while the raw water contained about 8,000 cc. Upon the whole, we can say that the new process of filtration produces a water perfectly limpid, clear and practically free from the microbes of the raw water.”

The writer, as consulting engineer of the Jewell Export Filter Co., prepared the detail plans of the filters and their auxiliaries, detail plans of the coagulation and subsidence basins, and preliminary plans for the entire filter plant. Mr. Karl Abel, engineer of the Ministry of the Interior, prepared the detail plans of the filter building and the other detail plans necessary and supervised the erection of the filter plant on behalf of the government and municipality of Mansourah. Mr. R. W. Lawton represented the Jewell Export Filter Co., as their superintendent of construction, at Mansourah, during the building of the filter plant.

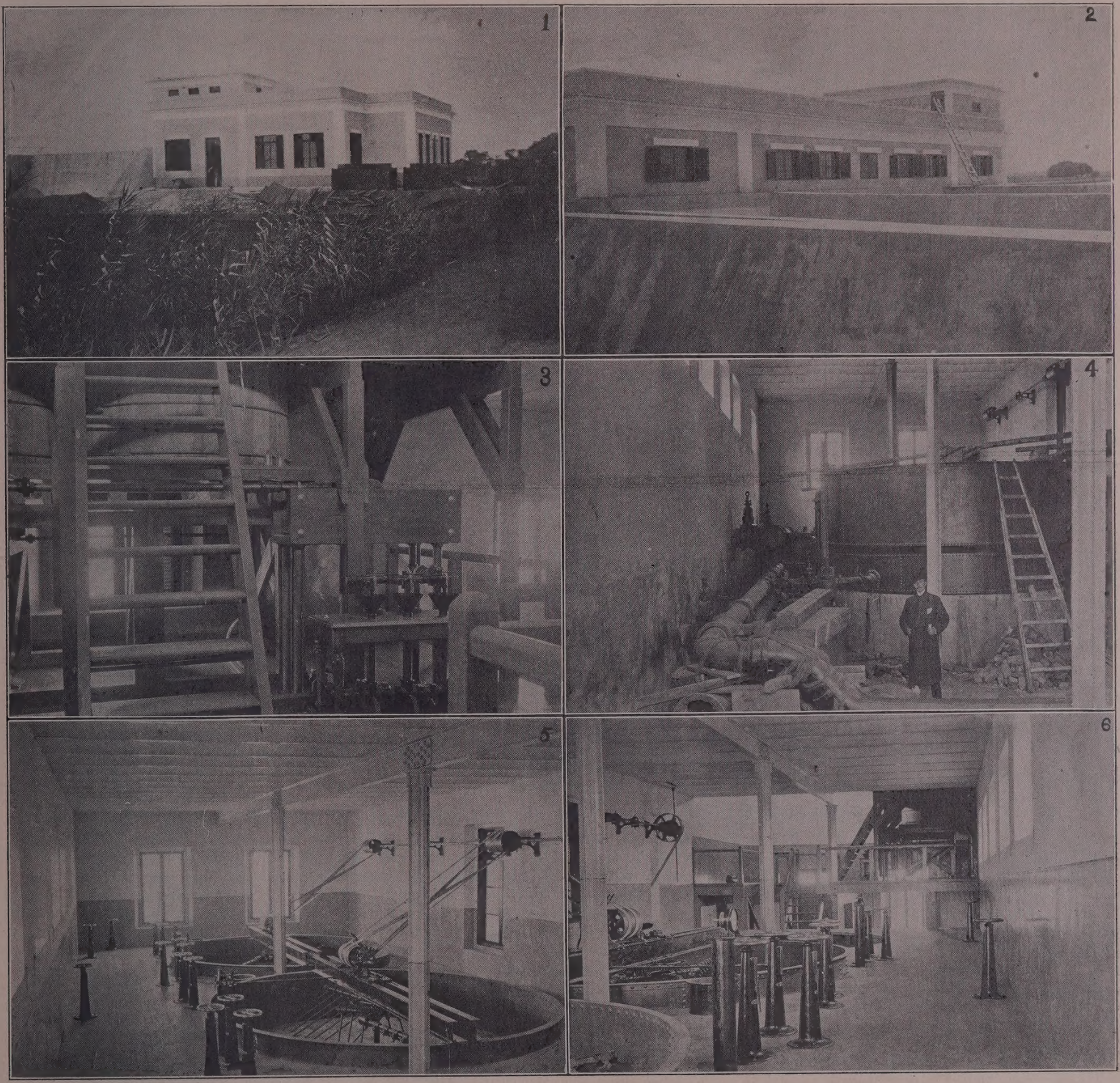
The accompanying reproductions of photographs are made from views which were taken before the third filter and the third coagulation and subsidence basin were built. Photographs of the third filter and third basin have not been taken, as the Jewell Export Filter Company's superintendent of construction had not time to do this after the third filter and third basin were completed, as it was necessary for him to proceed immediately to Gera, Germany, to take charge of the erection of another filter plant for the company at that place.

The illustration at the head of this article shows a view of the filter building and of the canal from which the raw water is pumped to the coagulation and subsidence basins.

Fig. 1 in the group of reproductions from photographs shows a view of the filter building and the side wall of coagulation and subsidence basin No. 2 arranged for connecting basin No. 3, which is now built.

Fig. 2 shows a view of the rear side of the filter building and a portion of the walls of two coagulation and subsidence basins. The details of the coagulant feed apparatus are shown in a fourth engraving. Fig. 3 shows a view of a portion of the coagulant feed apparatus.

Fig. 4 shows a view of a filter and auxiliaries in course of erection. Fig. 5 shows a view of the filter room above the operating floor and two filters, and Fig. 6 shows a view of the filter room above the operating floor and portions of two filters and an opening for the third filter, and a portion of the coagulant feed apparatus beyond.

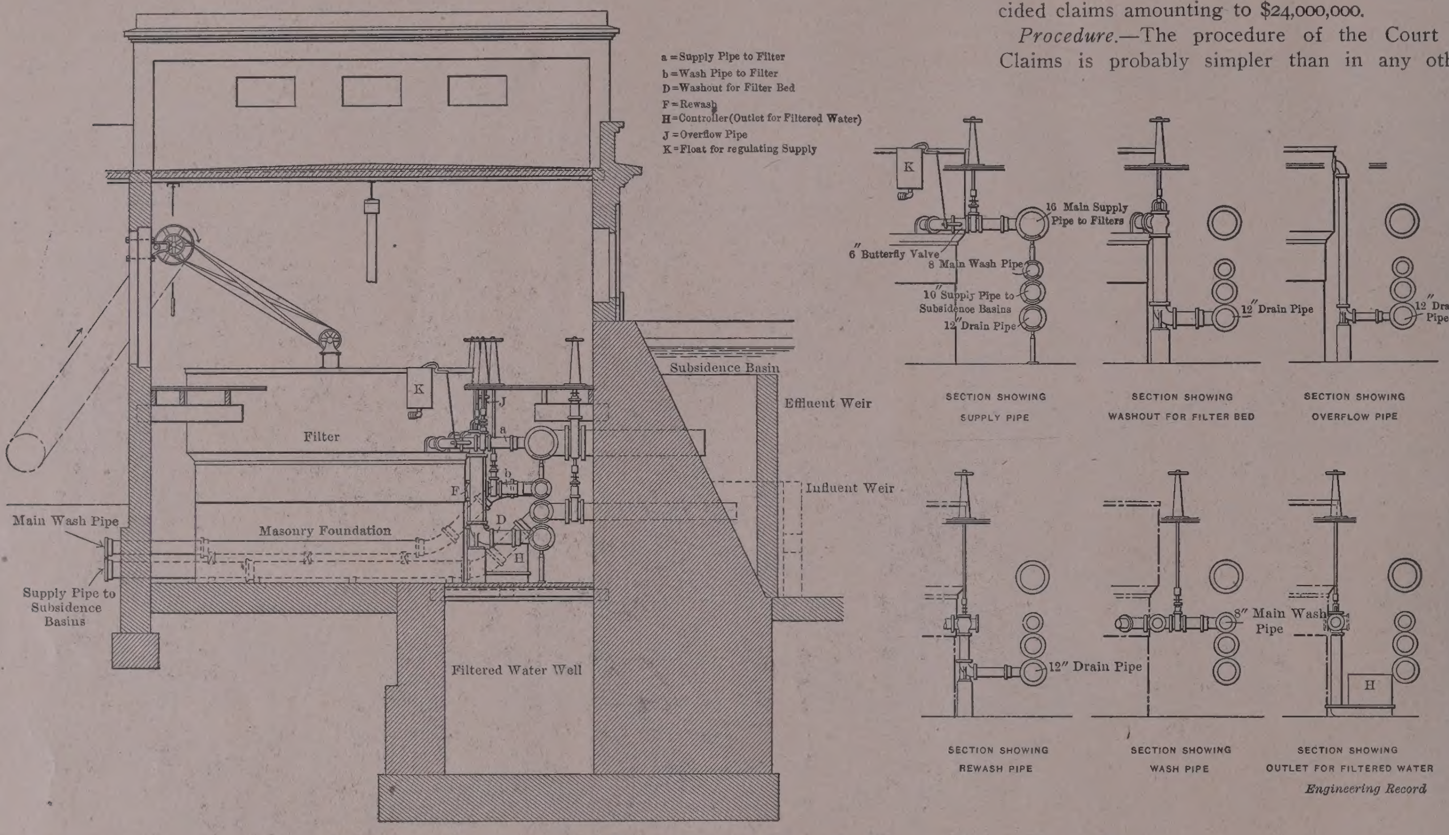


Views of the Water Filters of the American Type Installed at Mansourah, Egypt.

The plan of the filter room shows the location of the three filters and their auxiliaries, and parts of the ends of the adjoining three coagulation and subsidence basins. The pump and motor room in which the pumping outfits are located, and the store room and offices, are not shown, but are situated back of the filters in the front part of the building. Another line engraving gives a cross-section of the filter room, the filtered water well, and one end of a coagulation and subsidence basin, and also shows the details of the connections to one filter.

A third line engraving shows a longitudinal section of the filter room and filtered water well, in front of and looking toward the three filters.

It would appear from the experience of a tourist, interested in the purification of water, while in Egypt a few years ago that a very crude and primitive form of the American system of filtration had been in vogue there for many years. He noticed in one region on the banks of the River Nile that the natives placed a certain kind of earth in large earthenware vessels, and filtered water through the earth and earthenware. The water which was brought from the river in goat skins he found to be very vile, while the effluent resulting from the filtration was extremely clear. He was greatly astonished and obtained some of the earth and found when it had dried that it was covered with a white crystalline substance. Upon analysis this substance proved to be alum. He also saw while in Egypt hieroglyphics representing natives carrying water in skins and filtering it through earthenware vessels in the same manner as he had seen natives doing, which led him to believe that alum, probably unknowingly, was used by the ancient Egyptians, in their crude form of filtration as above described, several centuries before the Christian era.


a = Supply Pipe to Filter
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D = Washout for Filter Bed
F = Rewash
H = Controller (Outlet for Filtered Water)
J = Overflow Pipe
K = Float for regulating Supply
K
J
a
b
F
D
H
Filter
Main Wash Pipe
Masonry Foundation
Supply Pipe to Subsidence Basins
Filtered Water Well
Subsidence Basin
Effluent Weir
Influent Weir
16 Main Supply Pipe to Filters
6" Butterfly Valve
8 Main Wash Pipe
10" Supply Pipe to Subsidence Basins
12" Drain Pipe
12" Drain Pipe
12" Drain Pipe
SECTION SHOWING SUPPLY PIPE
SECTION SHOWING WASHOUT FOR FILTER BED
SECTION SHOWING OVERFLOW PIPE
12" Drain Pipe
8" Main Wash Pipe
H
SECTION SHOWING REWASH PIPE
SECTION SHOWING WASH PIPE
SECTION SHOWING OUTLET FOR FILTERED WATER

Engineering Record

Cross-Sections of Mansourah Filters Showing Pipes, Shafting and Connections to Basin.

STREET RAILWAY CIRCUITS as a source of power are growing in favor in Germany, about 350 motors of 1,900 h.-p. rating being supplied from such circuits in Dresden alone. Inter-pole motors have been found particularly serviceable for such installations.

Government Contracts;—Legal Pitfalls and How to Avoid Them.—IX.

By George A. King and William B. King, Members of the Bar of the Court of Claims.

Suing the Government.—The discussion of the law of government contracts contained in the preceding eight chapters has attempted to show, first, the rights of contractors in controversies arising between them and government officers, and secondly, the steps necessary to preserve such rights. It is now necessary to consider what remedy in court is provided by the laws of the United States for contractors who have just grounds for complaint.

Jurisdiction of the Court of Claims.—Jurisdiction is given by act of Congress to the Court of Claims "to hear and determine all claims founded upon any contract, expressed or implied, with the Government of the United States, in respect of which claims the party would be entitled to redress against the United States either in the court of law, equity or admiralty, if the United States were suable."

This is a broad grant of jurisdiction and gives a right to contractors to seek redress in all cases where, as between individuals, that redress would take the form of a judgment or decree for the payment of money. The Court of Claims cannot issue injunctions, decree specific performance or grant any other form of relief than a money judgment.

A Judicial Body.—The Court of Claims has itself stated the object of its existence, saying that it is "a court created to aid honest suitors in getting their dues from the Treasury." It is a judicial body, a court in the proper sense of the term. The Supreme Court has said that "The Court of Claims exercises all the functions of a court" and that it is one of those courts inferior to the Supreme Court which Congress may authorize under the Constitution. Thus recognizing the Court of Claims as a court, the Supreme Court takes jurisdiction of appeals from its decisions.

The Court of Claims is entirely independent of the executive departments. "Its decisions, not appealed from" it says in a well-known case, "are guides to the executive officers of the government and furnish precedents for the executive departments in all other like cases."

Sessions of the Court.—The court is composed of five judges who sit together without a jury and decide both the facts and the law. Their decisions upon the facts are final, while their decisions upon the law may be reviewed by the Supreme Court of the United States. The sessions of the court begin in October and continue until June and are all held in Washington.

History and Work.—The court has but recently celebrated its fiftieth anniversary. The original act of 1855, creating it, has been repeatedly amended, always in the direction of enlarging its powers and increasing its jurisdiction.

The magnitude of its business is shown by the last report of the Attorney-General, which states that in the year ending October 31, 1905, it decided claims amounting to $24,000,000.

Procedure.—The procedure of the Court of Claims is probably simpler than in any other court of record in the United States. There are no technicalities of pleading. The whole aim of the rules and practice of this court is to reach the merits of each case brought before it, without regard to purely technical questions.

Evidence.—Testimony of witnesses for use in the Court of Claims is taken in writing upon oral examination and cross-examination by counsel, the same as in equity cases in State courts. It is taken in the locality where the witness resides. Any notary public may act as a commissioner of the court and the evidence, when reduced to writing, is filed in the court.

In taking testimony frequent technical objections to evidence, such as are often made in other courts, are of minor importance. On the other hand, the court insists upon great particularity in the statements of the witnesses and the evidence, it may be said generally, must be produced more in detail than is usual in suits between private individuals.

This is illustrated in a very recent case where the court said that "the evidence is too general and unsatisfactory" to establish the facts, though "conceding that for some of the claim the claimant might be entitled to recover." It is very probable that the knowledge of the witnesses, if fully brought out, would have proved the case.

The records of the departments are made by law accessible to the Court of Claims and are often of the greatest importance.

Argument.—When the evidence is taken, written or printed briefs are presented on both sides and the case is orally argued before the five judges composing the court.

In preparing the argument, special need is found of familiarity with the court's decisions. There are now forty volumes of decisions of the Court of Claims and many decisions of the Supreme Court on appeal are scattered among more than a hundred volumes of the reports of that court. Counsel writing a brief or engaged in an oral argument should be ready to cite any of these decisions which have a bearing upon the case.

Length of Time.—The length of time which a suit requires in the Court of Claims varies with the subject-matter and the conditions of the claim. Some years ago the volume of business before the Court of Claims so suddenly increased under laws then recently made, that great delays occurred, chiefly in the preparation of the defense by the officers of the United States. At the present time these delays have been largely avoided. Some instances in the writer's practice will show the length of time required for decision of a claim arising under contract. Three suits were presented to the Court of Claims on March 30, June 30 and July 17, 1902, respectively, the first based upon a contract for building a snag boat, the second for the completion and purchase of a transport steamer, and the third for clothing for the Indian service. They originated in widely scattered parts of the country, one in Indiana, one in the State of Washington and one in New York. Judgments for the claimants in the three cases were rendered on January 4, May 16, and April 4, 1904, each within two years of the presentation of the suit.

Simpler claims may be disposed of in a shorter time, while very large claims, involving the taking of many depositions and an elaborate defense, will necessarily be protracted.

There are no court costs in the Court of Claims in the proper sense of the word, that is to say, nothing is paid to the clerk of the court as docket or other fees. The theory is that this is a court in which the government offers untaxed justice to all who claim to be its creditors.

The rules of the court require the claimant's petition and brief to be printed at his own expense. This does not usually exceed $25 in claims not involving complicated issues and may be less. In large cases where the issues are complicated the discussion has to be more elaborate and the printing of the brief costs correspondingly more.

The taking of testimony for the claimant is a charge which each claimant must incur. No general statement can be made of this expense, as it necessarily varies according to the character of the litigation. The court has fixed maximum charges which can be made by notaries or other commissioners taking testimony. Some contract claims, involving questions of law alone, may be tried upon the record evidence from the departments. This is particularly true in claiming remission of penalties, where testimony is not always requisite.

The system of contingent fees for counsel for claimants prevails in the court. This practice has been approved in a number of decisions of the Supreme Court of the United States. In one leading case the following views were expressed: "It was decided in an earlier case that contracts by attorneys for compensation in prosecuting claims against the United States were not void because the amount of it was made contingent upon success, or upon the sum recovered. And the well-known difficulties and delays in obtaining payment of just claims which are not within the ordinary course of procedure of the auditing officers of the government, justifies a liberal compensation in successful cases, where none is to be received in case of failure. Any other rule would work much hardship in cases of creditors of small means residing far from the seat of government, who can give neither money nor personal attention to securing their rights."

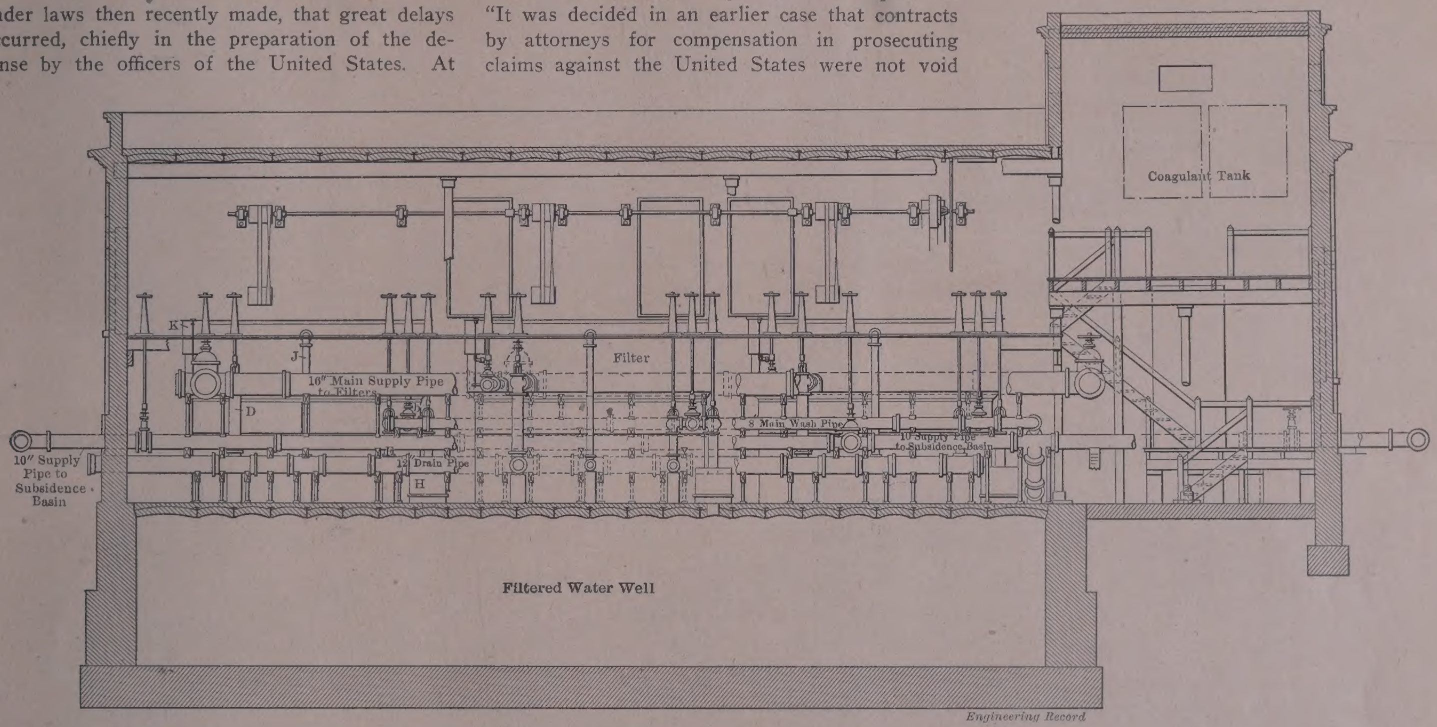
Limitation.—The question of limitation is of importance. The time for filing claims in the court expires in six years from the date when the claim originated. In contract cases, speaking generally, that is six years from the date of final payment under the contract. The presentation of a claim to the Department does not bar the running of the statute of limitation in the Court of Claims except under some special conditions. It must be presented to the court within six years to save the contractor's rights.

Principles of Law.—The development since 1863 of the principles of law controlling government contracts has been progressive.

The underlying principle of first importance was very broadly stated by the Supreme Court of the United States in 1879: "The United States, when they contract with their citizens, are controlled by the same laws that govern the citizens in that behalf. All obligations which would be implied against citizens under the same circumstances will be implied against them." A few years later the same principle was stated in another case in the following language: "The United States would have been liable to damages for its breach on the same principles and to the same extent as a private party, for which a suitable remedy was provided by law in the jurisdiction conferred upon the Court of Claims. In this respect the relation between the parties was that of perfect equality in right." In still another case, the Supreme Court held the government liable because under the circumstance "There would be no hesitation in holding an individual liable."

Some limitation of the application of this principle results from the many statutes for the protection of the government. These often control the action of the courts. These statutes, as well as the essential differences in the general conditions under which the government makes contracts, must to some degree cause a distinction in some details between the rights of contractors with the government and the rights of the parties in contracts between individuals. Instances of this have been repeatedly shown in the preceding chapters of this discussion.

While recognizing the same obligations on the part of the United States as are assumed under like contracts by private individuals, no wider principle of liability is admitted. Thus the Supreme Court more than thirty years ago declared that appeals merely to the generosity of the United States could not be considered by that court. They said: "There is in a large class of cases coming before us from the Court of Claims a constant and ever-recurring attempt to apply to contracts made by the government, and to give to its action under such contracts, a construction and an effect quite different from those which courts of justice are accustomed to apply to contracts between individuals. There arises in the minds of parties and counsel interested for the individual against the United States a sense of the power and resources of this great govern-

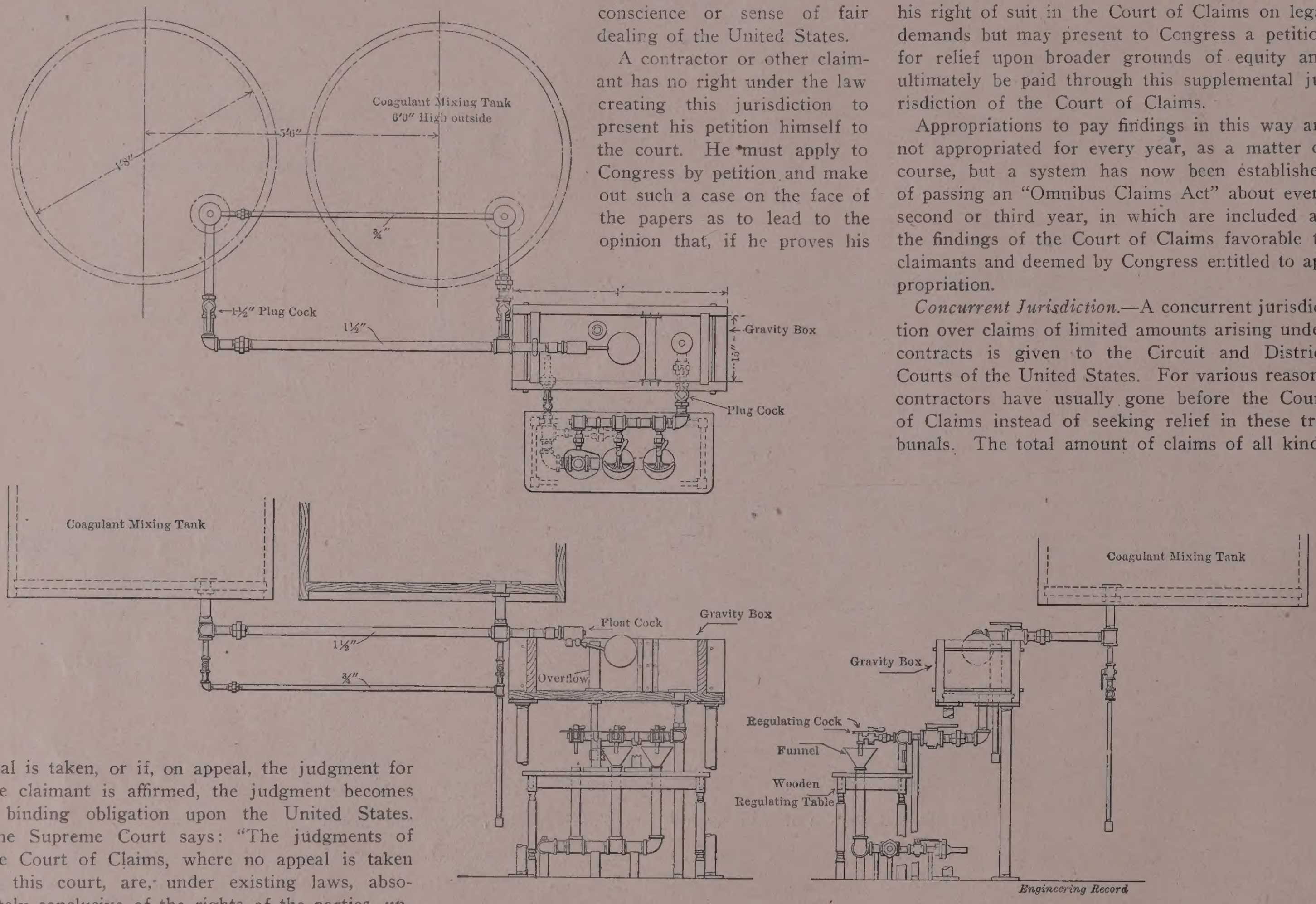

Coagulant Tank
K
J
16" Main Supply Pipe to Filters
D
Filter
8 Main Wash Pipe
10" Supply Pipe to Subsidence Basin
10" Supply Pipe to Subsidence Basin
12 Drain Pipe
H
Filtered Water Well
Engineering Record

Longitudinal Section of Mansourah Filters, Showing Pipes, Filters and Shafting.

ment, prompting appeals to its magnanimity and generosity, to abstract ideas of equity, coloring even the closest legal argument. These are addressed in vain to this court."

Contractors coming before the Court of Claims and the Supreme Court, except under a special jurisdiction which will be discussed later, must base their claims entirely upon rights which can be recognized in courts and not upon appeals to abstract justice.

Payment of Judgments.—A general misapprehension exists in regard to payment of the judgments of the Court of Claims. When a judgment is rendered by the Court of Claims in favor of any contractor or other claimant, the government has a right to appeal to the Supreme Court of the United States. If no appeal is taken, or if, on appeal, the judgment for the claimant is affirmed, the judgment becomes a binding obligation upon the United States. The Supreme Court says: "The judgments of the Court of Claims, where no appeal is taken to this court, are, under existing laws, absolutely conclusive of the rights of the parties, unless a new trial is granted by that court." "The judgment of the Court of Claims from which no appeal is taken is just as conclusive under existing laws as the judgment of the Supreme Court, until it is set aside on a motion for new trial."



Details of Coagulant Feed, Mansourah Filter Plant.

Such binding obligations of the United States are always recognized and paid. It is true that under the present system no general appropriation exists out of which such judgments can be paid immediately upon rendition, but a special appropriation is made every year for the purpose.

The attorney for the claimant delivers to the Secretary of the Treasury a transcript of the judgment in favor of his client. At the proper time in the session of Congress, the Secretary is obliged by law to send to the House of Representatives a list of such judgments and an appropriation is made for their payment in the ordinary routine of business at each session of Congress on the General Deficiency Appropriation Act, which passes at the close of each session. In the long sessions it has come to be the custom to appropriate for judgments rendered up to the 1st of January in the Urgent Deficiency Act which passes near the beginning of each session. The appropriation to pay judgments of the Court of Claims is now as much a regular matter of congressional routine as that to pay the salary of the President or the expenses of the postal service. Any contractor who has a judgment in the Court of Claims is entirely assured of his money.

A Secondary Jurisdiction.—The misapprehension on this subject doubtless has arisen from the fact that the Court of Claims has a separate jurisdiction in which no judgment is rendered. This jurisdiction may in exceptional cases be sought by contractors who have suffered under hardships which cannot be redressed under the rules of legal right, enforceable by suit, but which appeal only to the good conscience or sense of fair dealing of the United States.

A contractor or other claimant has no right under the law creating this jurisdiction to present his petition himself to the court. He must apply to Congress by petition and make out such a case on the face of the papers as to lead to the opinion that, if he proves his case, he ought in justice to be paid from the Treasury. Either house of Congress or any committee may thereupon refer such a claim to the Court of Claims. The court can enter no judgment under such conditions, payable as a binding obligation. It may make only a finding of the facts which is reported back to Congress. Appropriations may be made or not, as the facts found by the court appeal to the sense of justice of Congress.

An instance of this occurred in connection with the building of certain war vessels in the Civil War. The contractors were greatly delayed by the government requiring extra work. Their claims were referred to a special naval board which made small allowances under very rigorous rules. The parties accepted the amounts allowed, receipting in full in many cases under protest. The Court of Claims denied their right of action at law because of their receipt of the amount allowed by the board, considering the claims compromised and settled under the decisions of the Supreme Court on this subject, discussed in the chapter of this work on Receipt in Full. The contractors applied to Congress for relief from this severe rule of law and the Senate referred the claims to the Court of Claims under the statute authorizing a finding of the facts, but no judgment.

The Court of Claims has already, under the authority of this law, found the facts in a number of these cases. These show that the contractors actually did more work than that for which they have been paid and were damaged by reason of the delay of the United States for which under their contract they were not to be responsible. Congress has appropriated to pay the claims in which the facts were so found and will doubtless do so in other cases as reported by the Court of Claims.

A contractor is therefore not limited solely to his right of suit in the Court of Claims on legal demands but may present to Congress a petition for relief upon broader grounds of equity and ultimately be paid through this supplemental jurisdiction of the Court of Claims.

Appropriations to pay findings in this way are not appropriated for every year, as a matter of course, but a system has now been established of passing an "Omnibus Claims Act" about every second or third year, in which are included all the findings of the Court of Claims favorable to claimants and deemed by Congress entitled to appropriation.

Concurrent Jurisdiction.—A concurrent jurisdiction over claims of limited amounts arising under contracts is given to the Circuit and District Courts of the United States. For various reasons contractors have usually gone before the Court of Claims instead of seeking relief in these tribunals. The total amount of claims of all kinds brought before these courts during the year ending October 31, 1905, was $41,936. This may be contrasted with the enormous figures heretofore quoted of the work done by the Court of Claims during the same period.

Who Have Recovered.—The leading contractors of the country have sought and obtained relief through actions in the Court of Claims. Among some of the judgments in contract cases rendered during the last few years the following are cited: Harvey Steel Co., $650,132.17 and $64,758.03; Beckwith & Quackenbush, $130,736.18; Utah, Nevada & California Stage Co., $88,261.55; Union Transfer Co., $41,801; Estate of James B. Eads, $26,409.81; Dittmar Powder Works, $24,137.13; Bethlehem Steel Co., $21,000; Houston Construction Co., $17,706.49; Whaley & Taylor, $16,639.25; San Francisco Bridge Co., $15,744.17; Phoenix Iron Co., $14,276.45; D. S. Hess & Co., $9,365.44; William A. Kimmel, $8,465.35; P. H. McLaughlin, $7,341; M. A. Sweeny Ship Yard & Foundry Co., $6,560; Bay State Clothing Co., $6,-

366.65; Bryan, Barlow & Co., $5,367.96; Moran Brothers Co., $4,880; Cotton Brothers Co., $4,093.

Numerous other judgments have been rendered for smaller sums under miscellaneous contracts and for considerable sums in favor of railroad companies for mail transportation.

No Harm to Contractors.—A contractor who has ground for suit against the United States often asks what may be the effect of such suit on his obtaining or executing other contracts.

The right of access to the Court of Claims is a right granted by law. Any contractor who thinks that he is aggrieved has a lawful right to secure redress through the Court of Claims. It would be extreme tyranny for any officer of the government to try to punish a contractor, because he exercises such a right. Indeed, many of the government officers who have charge of contracts have themselves been interested in suits in the Court of Claims and have benefited by increase of pay, resulting from such decisions.

In the fifty years since the Court of Claims was established, no case is known where any government officer assumed the right to discriminate in any way against a contractor because he had entered a suit. If the entry of a suit by a contractor under one contract could have any bearing upon his future contracts, it would probably be beneficial to him, in serving as a notice to any officer of the government who is inclined to act capriciously that this contractor knows his rights and is prepared to assert them at the proper time and before the proper tribunal.

Contractors who have grievances against the government or its officers may therefore be sure that there is no danger to them in proceeding in the Court of Claims as authorized by law.

Numerous instances have occurred where contractors have prosecuted suits for balances due under one contract while carrying on other contracts at the same time. In the writers' own practice, a claim for over a quarter of a million dollars is in active prosecution before the Court of Claims for a firm of contractors who are at the present time engaged in fulfilling one of the largest contracts under the Engineer Department of the army.

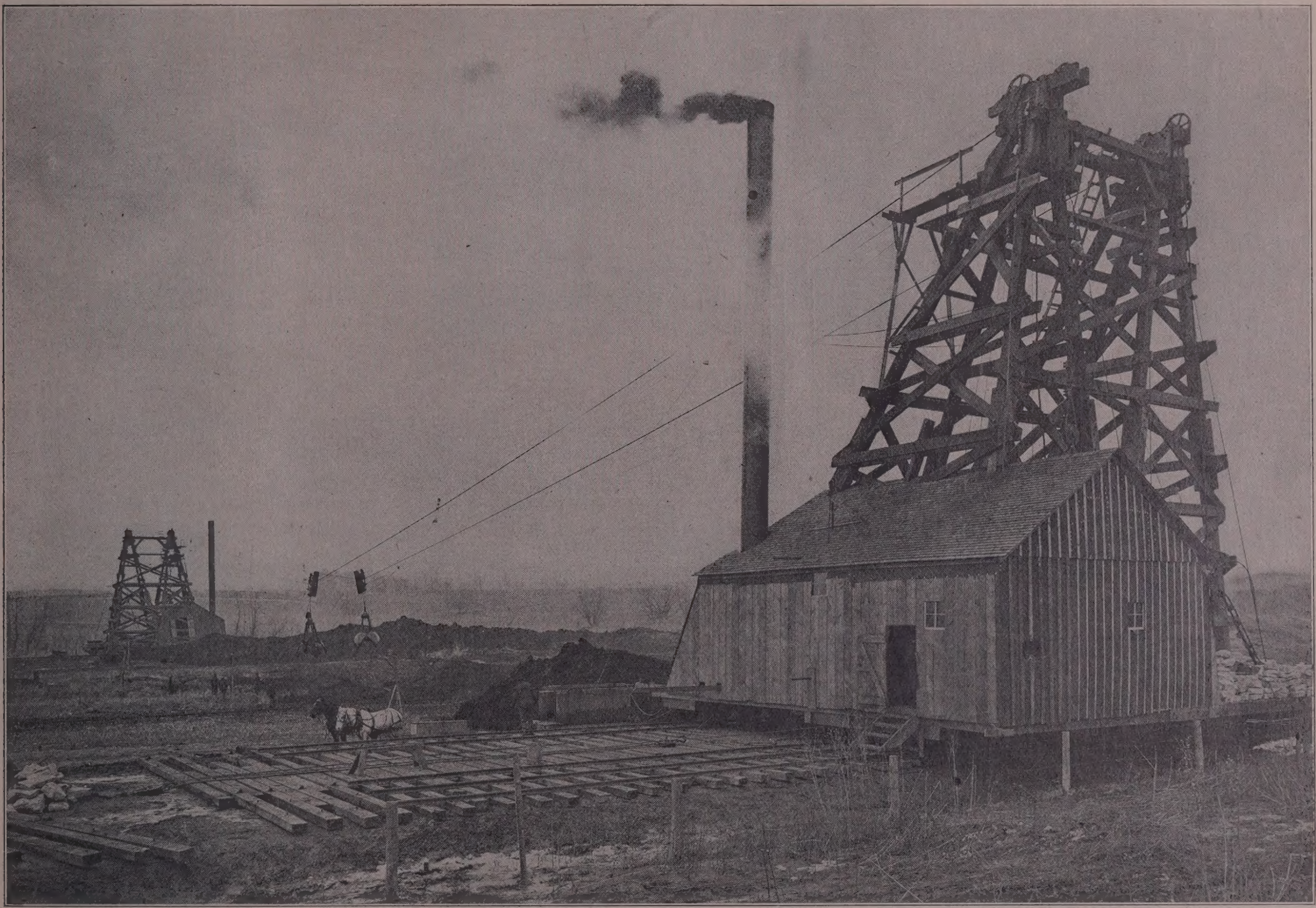
Advice in Pending Contracts.—A final word of advice to contractors is of importance. The best work which a lawyer can do for his client is to keep him out of the court. If, during the progress of a contract, a client can be so advised from time to time as to avoid litigation, the lawyer has done him the best possible service.

The next best service is to advise him so soundly during the contract that, if litigation comes, the contractor will be in the best possible position for success. One thing stands out prominently through the preceding chapters of this discussion, that many a suit against the government, which was lost, might have been won, if the contractor had taken proper precaution to preserve his rights while the contract was in progress. The need of suit could have been avoided in other cases, had the right course been followed from the beginning. No better admonition can be given to contractors, in closing this discussion, than to urge the need of consulting counsel in time. Sound advice promptly sought and discreetly followed will avoid litigation, or, if unavoidable, will insure success when litigation comes.

AN OPEN FEED-WATER HEATER installed in a 50-h.-p. non-condensing plant recently is said to have produced a direct saving of one ton of coal in 11 days.

Difficult Excavation on the Hennepin Canal.

Excavation of a troublesome section of the Hennepin or Illinois & Mississippi ship canal under construction by the U. S. Government, was commenced by contractors who eventually found the difficulties so great that they abandoned the work. It is now being executed by the Government under the direction of Col. W. H. Bixby, Corps of Engineers, U. S. A. Near Wyanet, Ill., where work is now in progress, the soil is very bad, consisting mostly of peat containing quicksand and generally full of water, making the excavation difficult and causing great trouble and expense for the maintenance of surface tracks and the installation of machinery.



Traveling Cableway Used on the Construction of the Hennepin Canal.

The excavation is being made by a Lidgerwood duplex traveling cableway of special design, unlike any which have previously been built, which was purchased and installed under the direction of Major C. S. Riché, Corps of Engineers, U. S. A., during 1903-1904. It consists essentially of two cableways 18 ft. apart transverse to the canal axis and moving parallel with it on a pair of timber towers 650 ft. apart from out to out. Each cableway is equipped with a 1½-yd. Heyward orange peel excavating bucket which is operated entirely from the tower so as to descend, load itself, ascend, travel to the spoil bank, dump and return for another load without requiring any attention other than is given by the operator in the tower.

The canal has a bottom width of about 52 ft. and side slopes of two to one. On each side of it about 100 to 125 ft. is unobstructed for towpath, ditches, railroad tracks and other purposes and a spoil bank from 80 to 100 ft. wide at the bottom and 18 ft. high with 1½ to one slopes is made 125 ft. or more in the clear from the edge of the canal. Outside of each spoil bank there are laid five lines of rails parallel to the axis of the canal. They are arranged to form two standard-gauge tracks 29 ft. apart on centers and one additional line 5 ft. inside the inner rail of the outer track. The towers move on these rails clearing the spoil banks.

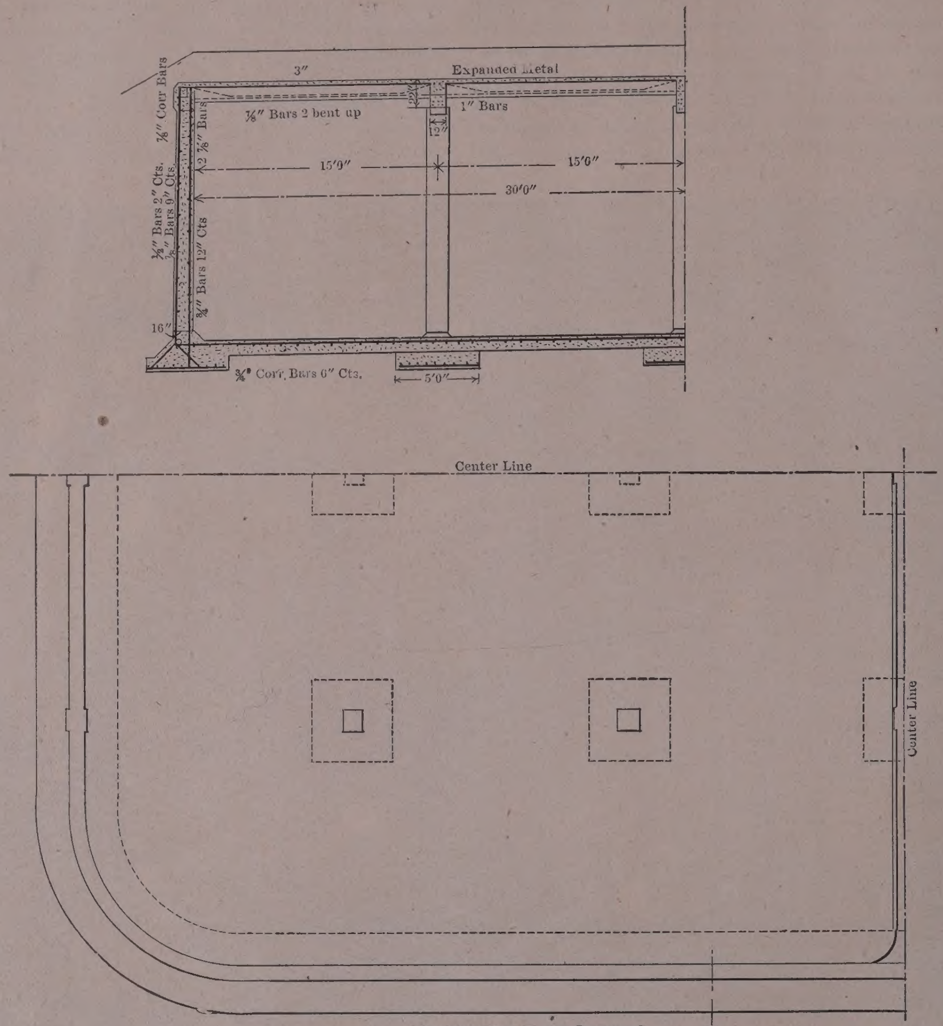
The plant is designed to have one bucket work on each side of the canal, both at the same time excavating, dumping and returning with the minimum amount of travel, although, as both buckets are handled independently, either one can operate over the entire length of the span and dump on either side, although each is generally operated only on the side nearest its engine. The nearest approach to this system which had been previously constructed was a duplex traveling cableway of 475 ft. span which was built by the Lidgerwood Manufacturing Company to handle logs at Waterville, Me. It differs, however, from the one here described in that only one engine was installed and operated a log hoist suspended from two trolleys, one on each cable, thus affording supports for the logs near each end. Only a single hoisting and traversing apparatus was provided and the towers were not duplicates, one of them being a head tower and the other a tail tower.

The towers of the Hennepin Canal plant are duplicates, each of them being fitted with an engine and boiler to operate one cableway. Each consists essentially of two twin towers, which are rigidly braced together on the same longitudinal axis, one of them serving as head tower for one cableway and the other serving as tail tower for the other cableway. They are both mounted on a single 47x54-ft. horizontal platform, are 57 ft. high over all and are built of heavy timber rigidly braced and bolted at all connections. The back of the tower is vertical and the opposite face nearest the canal is battered to form a wedge-shape pyramid.

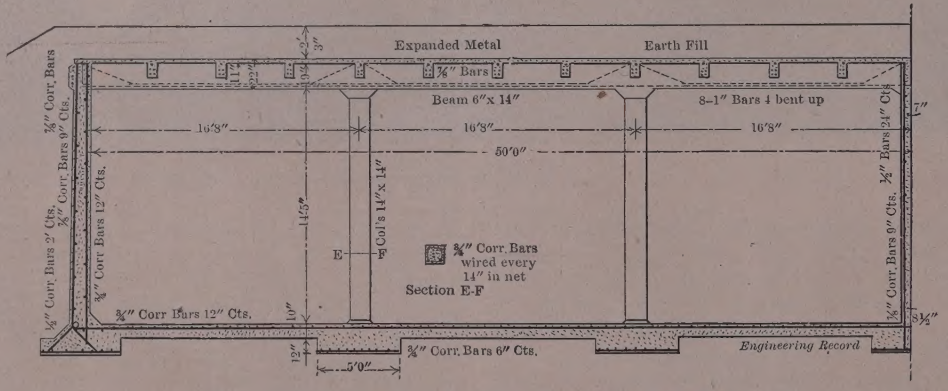
Each tower contains about 40,000 ft. b. m. of timber and two tons of iron work and is mounted on 48 standard car wheels set in two parallel frames 54 ft. long which are X-braced together with horizontal sleeve nut rods. The plumb and batter legs are 12x12-in., the diagonal braces are 3x12-in. and 4x12-in. and other material is mostly 6x12-in., 8x12-in. and 10x12-in. The tower platform cantilevers beyond the outside track end and is counterweighted with about 20 tons of rock ballast besides 35 tons of engine and boiler, thus providing for the reactions from the two 2-in. main cables 18 ft. apart on centers and the two buckets, which, together with their carriages and loads, weigh about 15 tons. The maximum weight of one tower and load is approximately 200 tons.

Each tower has a special 12¼x15-in. double-cableway engine with three tandem 51-in. friction drums and a 125-h.p. locomotive fire-box boiler. The total force, exclusive of track layers, is one engine man, one fireman and one signal man for each of the two cableways. The capacity of the machine is such that during the first season's work each bucket excavated 500 yd. of material in one 8-hr. shift, thus making under favorable circumstances a product of 3,000 yd. a day for the machine running continuously with three 8-hr. shifts, of six men each. When built in 1904 the cableways were constructed with a 525-ft. clear span, which was increased in 1905 to 625 ft. and the size of the bucket was changed to 1¾ cu. yd., on account of some harder material being encountered.

The soil is so soft and unstable that the banks are constantly caving in. In spite of the fact that a berm of from 100 to 125 ft. is left between the edges of the cutting and the spoil bank, the weight of the latter on the soft ground causes the bottom of the canal to rise in the center. This makes it necessary to return the cableway for cleaning up. This extra moving increases the cost of doing the work and diminishes the output. The largest output in one month for 1905 was in August, 48,948 cu. yd., costing 10.7 cents. The lowest monthly cost per cubic yard was in August, 1904, when the output was 51,074 cu. yd. at 6.8 cents per cu. yd. In figuring this amount per cubic yard a considerable portion of it was for laying the tracks for the cableway to travel along the canal. It is evident, therefore, that if the canal section had been greater the cost per cubic yard would be less. These figures, however, both as to output and yardage compare very well with steam shovel records, and they are remarkable considering that this material is excavated, then conveyed and delivered more than 200 ft. away.



Quarter Plan (Cover Removed)



General Construction of Reservoir at Ft. Meade, S. Dak.

Other interesting records are as follows: A ten-day's run ending August 20, 1904, showed an output of 15,875 yd. at a cost of 5.9 cts. per yd., an average of nearly 1,600 yd. per day. During the first 10 days of December, 1905, 65½ tons of coal at $2.25 per ton was used. During 1905 breakages and repairs were very light, but the material excavated was harder than that encountered in 1904, and some of it was hardpan, thus accounting for the increased cost per yard. The average cost per yard for excavating 526,534 yd. of material up to about January 1, 1906, has been 15.1 cents, or taking into consideration the original cost of the entire plant 20.60 cents. This total cost is gradually reduced as cost of plant is distributed over an increasing number of yards. These amounts include all repairs, the installation of new cables, the change of span and bucket size and expense incurred by interruptions of the work.

The plant was designed, manufactured and installed by the Lidgerwood Manufacturing Company, New York, under charge of Mr. Frank B. Knight, one of their cableway engineers.

Reinforced-Concrete Reservoir at Fort Meade.

A 500,000-gal. reinforced-concrete reservoir, with a flat slab roof carried by beams and girders supported on square reinforced-concrete columns, has recently been completed at the United States cavalry post at Fort Meade, S. D. This post has been made a permanent one by the general government and a number of brick and stone buildings have been erected in connection with it in recent years, about $200,000 being involved in buildings now under construction. The post is 2 miles from the town of Sturgis, S. D., and its water supply is furnished from the water works system of that town. The supply of the latter is drawn from streams which have their source in a semi-circle of peaks in the Black Hills west of the town and post.

Prior to the construction of the 500,000-gal. reservoir and a pipe line connecting it with the distribution system at the post a 6-in. pipe line connected the mains in the town through a meter house with a 100,000-gal. reservoir near the post, and about 100 ft. above it. The distribution system of the post, consisting of 4-in. mains, was supplied from this reservoir. The improvements have been made chiefly to provide more adequate fire protection than that furnished by the old syster. The new reservoir is built on a hill 2,500 ft. from the meter house in town, and 9,500 ft. from the remote end of the distribution mains around the post. Its flow line is at an elevation of 3,380 ft. or 200 ft. above the post. An 8-in. cast-iron main was laid to connect it with the mains in town through the meter house, and an 8-in. main, 4,300 ft. long, was also laid from the reservoir to the distribution system at the post. Two lines of 6-in. pipe extend around the post from the end of the 8-in. main and connect with a gridiron system of 6-in. distribution mains.

Bottom of Excavation before Concrete Work Began.

The old 6-in. supply main was also connected with the new 8-in. main from the reservoir to the post about half way between the two points. A Mueller pressure regulator, set at 40 lb., is placed in the connecting pipe, and the old main still supplies the original buildings of the post. The new main supplies the more recently built structures and furnishes fire protection for all of them.

No unusual difficulties were experienced in laying any of the pipe lines. The material encountered in the trenches through high ground consisted for the most part of clayey loam. Gravel containing fair-sized stones mixed with fine sand and clay was generally met in the hillside work all along the lower portions of the route. The trenches were excavated by hand, the minimum depth of cover for the pipes being 5 ft. The backfilling, except through the parade ground at the post, was done with a drag scraper. In the parade ground the backfilling was puddled as placed.

The reservoir is a rectangle in plan, 60x100 ft. in the clear, and with rounded corners. It is divided in two equal compartments, each with a capacity of 250,000 gal., by a transverse wall on the center line. The floor is 10 in. thick and is reinforced with a gridiron arrangement of ¾-in. bars, 12 in. on centers in both directions. The floor, division and side walls are designed to resist the pressure of the ground when either or both compartments are empty, as well as the pressures resulting when either or both compartments are filled. The roof load is assumed to be amply provided for by considering the ultimate load 800 lb. per square foot, the actual load being a 24-in. earth fill and 100 lb. per square foot for snow. The column footings are 5 ft. square and 12 in. deep below the bottom of the regular floor. The wall footings are 5 ft. wide the full length of the walls. All footings are proportioned to keep the pressure on the foundation within 3,000 lb. per square foot, a grillage of bars in the column footings providing the required reinforcement to properly distribute the loads so the maximum pressure is not exceeded.

The columns are 14 in. square and are reinforced against flexure by four ¾-in. bars, one placed in each corner, and the four tied together with iron wire at intervals not greater than the diameter of the column, thus securing to a certain extent the increased allowable stress pertaining to hooped concrete. The columns are designed to carry the total load at an average unit stress of 500 lb. per square inch. The exterior walls, as well as the division wall, are considered vertical beams and reinforced accordingly with vertical bars, temperature stresses being provided for by horizontal reinforcement throughout the structure. Each compartment is divided in three transverse bays, and three longitudinal bays extend through both compartments. The roof slab and beams are carried directly by three longitudinal 12x22-in. girders, which rest directly on the columns and on the side and division walls. These girders are considered to act as T-beams, and each of them is reinforced toward the bottom by eight 1-in. bars in two rows of four each. Those in the upper row are bent up over the supports to provide for shear; the four bottom rods extend through in one plane. The roof beams are 6x14-in. in cross-section, and are each reinforced with four ⅞-in. bars. The roof slab is 3-in. thick and is reinforced with No. 16 2.5-in. mesh expanded metal. The reinforcing bars are all the Johnson corrugated steel bars made by the St. Louis Expanded Metal Fireproofing Co., that company also having furnished the expanded metal in the roof slab.

View of Forms when Walls Were Approaching Completion.

The piping connections of the reservoir are made so the two compartments may be operated separately, or so both may be thrown together. The 8-in. pipe from the meter house is connected to each compartment by an 8-in. inlet pipe that is controlled by an automatic valve actuated by a float set at the level of the top of an 8-in. overflow pipe in each compartment. The inlet pipes are also each controlled by a gate valve just outside the reservoir. An 8-in. outlet connecting with the main leading to the post is provided in each compartment. An 8-in. blowout pipe discharging into a drain with which the overflows are connected, is also placed in a sump in the bottom of each compartment. The piping connections are all made on both sides of the end of the dividing wall.

The concrete was mixed by hand in the proportions of 1 part cement, 2 parts sand and 4 parts crushed stone. Ideal Portland cement was employed in the greater part of the work, although some Sunflower Portland cement was used. A clean sand free from organic matter, but containing a greater proportion of fine grains than desired, was obtained in a bank about three miles from the reservoir. Limestone was quarried some distance from the reservoir and hauled in wagons to a crusher near the work for part of the concrete. Owing to the expense of the hauls small glacial boulders of quartz, granite and limestone, which were found in considerable quantity near the reservoir site, were afterward substituted for the quarried limestone. The specifications required the stone to be crushed to a size no larger than a ¾-in. cube, the run of the crusher being used.

The bottom of the excavation for the reservoir was made practically level and the concrete laid directly on it. The excavations for the wall and column footings were made slightly larger than the footing dimensions and 2-in. plank placed on edge around their sides before the concrete was laid. The lagging of the wall forms consisted of 2-in. plank, dressed on one side, and nailed to

4x4-in. uprights 4 ft. on centers in pairs on each side of the wall. The lagging in the forms for the round corners of the outside wall were thin boards sprung in position and nailed to posts 2 ft. apart. The column, beam, and roof slab forms were also 2-in. plank, properly braced.

The concrete was made wet enough to flow in the forms, and although it was spaded to allow the air bubbles to escape and to remove the stone from the outside faces of the walls, no tamping was required. A regular spade could not be used in the limited space between the vertical bars in the walls, so a 6x3x¾-in. iron paddle mounted on a ¾-in. round-iron handle, 5 ft. long, was used. The walls were carried up in practically uniform courses, no portion of the wall being more than 4 ft. above any other portion at any time. Each compartment was considered as a unit, and the concrete laid in horizontal layers around it. Stop boards with cleats nailed to them were placed vertically on the ends of sections when work was suspended temporarily, forming a groove into which the fresh concrete flowed when the stop board was removed. There were, however, few vertical joints.

After the concrete work was completed the floor and the inner surfaces of the compartment walls were finished with cement mortar. The finish on the floor is 1 in. thick and was laid in alternate strips. When the first strips had set the remaining ones were laid. The sidewall plastering is ¾ in. thick, and was applied in two coats. The mortar in the floor and side wall finish was made in the proportions of 1 part of Portland cement to 1 part sand, and a few hair cracks appeared on its surface when it had set. The whole surface was gone over with thin grout to fill these cracks. The outside surface of the walls and the top of the roof were painted with tar heated to 360° Fahrenheit and applied while hot with a brush.

The reservoir roof was covered with 2 ft. of earth and the embankment extended down on all sides on a slope of 1½ to 1 to the natural surface. This fill was made with teams and drag scrapers which were driven continually across the roof while making the fill without apparent deflection in or injury to the concrete. No leakage was perceptible nor any weakness apparent in any of the walls when both compartments were filled, or when either one was empty and the other filled.

The pipe line was laid and the reservoir built under the supervision of Major Geo. K. Hunter, 6th Savalry, U. S. A., constructing quartermaster. Mr. Samuel H. Lea, as civil engineer and superintendent of construction, had immediate charge of the work. The general design of the reservoir was made by the government officers, and the detailed designs by the St. Louis Expanded Metal Fireproofing Co., for Messrs. Dunnegan & Sykes, of Shenandoah, Iowa, who had the contract for the construction work. The pipe line was laid by the Dwyer Plumbing & Heating Co., of St. Paul, Minn.

Permission to Use Roads for water mains, street railway tracks, telephone and telegraph lines and the like, is so necessary to public-service corporations that unusual interest is attached to the recent decision of the Washington Supreme Court in State v. Town of Monroe, 82 Pac. Rep. 888. The court rules that under laws authorizing a board of county commissioners to lay out, discontinue or alter county roads or highways, and to do all other necessary acts, except in incorporated cities or towns where jurisdiction is vested in the corporate authorities, the board has no power to grant a franchise to lay pipes along or under the public highways. Such permission can only be given by the Legislature, and by boards directly delegated to grant it.

Thawing Frozen Ground with Hot Water.

The methods of thawing frozen ground with steam which are followed in Alaska were briefly described in this journal on Dec. 2, 1905. In the Fairbanks district these methods are not applicable, for reasons explained substantially as follows in a report by Mr. C. W. Purington, published by the U. S. Geological Survey. The feature of the Fairbanks gravel which affects this work is the fact that while the overlying layer of so-called muck is comparatively thin, from 2 to 7 ft. in the workings on the creeks themselves, exclusive of the slopes, the gravels, which are from 6 to 15 ft. in thickness, do not carry pay throughout their section, but only in the lower part. The pay is sometimes as thin as 6 in. in the gravel, and rarely exceeds 3 ft. It is then frequently necessary to take only a portion of the gravel down, and to run the drifts as low as possible, i. e., not to exceed 3½ ft. To do this economically and so that the top and barren gravel will not be continually caving and falling during the drifting, the ground must either be timbered or the method of steam thawing must be abandoned. Another reason why the method of steam thawing has a limited application in the Fairbanks district is the fact that the gravel is very argillaceous in its pay portion, and the thawing and drying with the steam result in a baking of the ground. Thus the gravel which was frozen becomes in its dry state cemented, and the difficulty of getting it out is not avoided but only lessened.

Thawing by means of hot water driven through a force pump and conducted to the bank by means of cotton hose and piped against the bank by means of a small fireman's nozzle is the most successful method which has been so far tried under the above-mentioned conditions. As regards the heating of the water, the system adopted at Fairbanks is to conduct the exhaust steam of the pump back into the suction of the pump as it draws water from a sump alongside of it. This has been found more effective than simply turning the exhaust pipe directly into the sump itself. The water used is sometimes supplied in sufficient quantity from the mere seepage from the ice mixed with the thawed gravel. But sometimes it will have to be introduced in the pit in small quantity. On the other hand, especially where thawed streaks occur naturally in the gravel, the water must be pumped out. This is done by the same pump used for the hydraulicking, without changing its position.

This method of thawing by hot water piped against the bank has two advantages. The strongest appears to be the fact that gravel thawed by this method can, as it were, be selected in the face, and no higher gravel than may be profitable need be taken down. The portion of the gravel above the part taken down remains solidly frozen, and consequently the roof of the drift or wide stope does not cave any worse than does the roof of solid muck in drifting operations where all the gravel in its complete vertical section is extracted. Another advantage is that the gravel is moved from its original position farther than by steam, and if it contains clay the clay has less opportunity to bake and cake than with steam thawing, and the amount of hand work in picking down the gravel is lessened.

A serious objection to thawing by hot water may justifiably be raised in cases where the bed rock consists of large slabs of schist, into which the gold sinks from 1 to 4 ft. and even more. In such a case the water cannot be piped to reach all the frozen gold-bearing material. On the other hand, where the bed rock consists of finely comminuted schist or softened, thoroughly rotten rock, even should the gold be found in it to the depth of 2 ft., there can be no valid objection to the hot water hydraulicking method. In the Nome district of Seward Peninsula, where the hot water method was tried, it was found that the water finally became too thick with sediment to be used in the pump, and the system was abandoned.

The Supervision of Water Supplies in New York State.

The question of the purity of water is of such great importance that it is of interest to know what provisions are made for its determination in New York, as ascertained by the State Water Supply Commission. It would be supposed that the local health officer exercised some control over public water supplies, but the Commission reports that, as a matter of fact, he rarely has such control, it being lodged either with local departments of public works or in water supply commissioners or in private corporations. With the exception of the excellent work carried on by a few of the larger cities in the matter of systematic examinations of water and those infrequently made for some of the private companies, New York State is deplorably deficient in the public supervision of its water supplies.

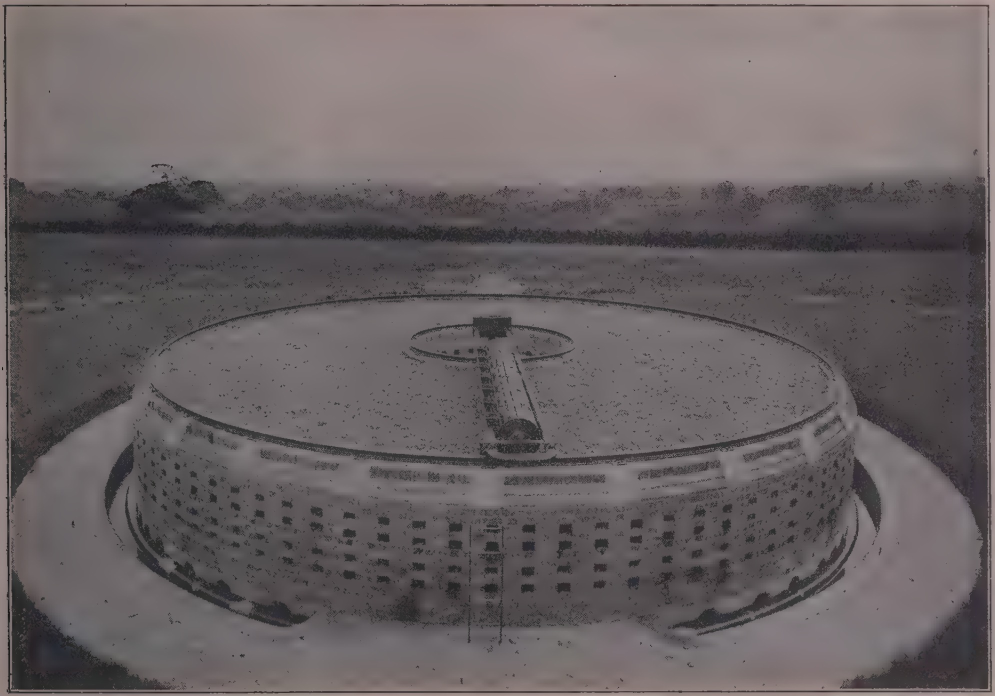
The remarkably successful results obtained in Massachusetts by State control of its water supplies has definitely determined the practicability and value of such supervision by State authority. It is unfortunate that New York has never given the attention to this subject that its importance deserves. While the New York State Board of Health during the last five years has made 1,402 analyses of samples of water and sewage, chemical and bacteriological tests being counted as separate analyses, during the same period the State Board of Health of Massachusetts has made over 30,000 such examinations, not counting chemical and bacteria tests separately. In Illinois a State Water Survey was instituted in 1895 and a law establishing a Chemical and Biological Survey was in force in July, 1897. In the ten years during which the work has been carried on 13,873 samples of water have been examined.

Water Meter Records in Brookline.

The Water Commissioners of Brookline, Mass., submitted a report to the town on Jan. 31, explaining the beneficial results of the universal meter system applied in the town between June 15 and Dec. 15, 1905. Not only was a large saving made in the consumption of water, but the date has been postponed when an additional supply will be necessary. About 364,000,000 gal. were pumped in the six months under consideration. Of this quantity 247,600,000 gal. were consumed by private users and 65,000,000 gal. by the town, leaving 51,000,000 gal., or 14 per cent., unaccounted for. This low percentage of loss is an excellent showing in comparison with the loss reported by other municipalities operating under the universal meter system. In New England this figure usually varies from 22 to 40 per cent. Less water was pumped by 57,000,000 gal. during these six months than was pumped during the corresponding six months of 1904. During December, 1905, the decrease below the previous December was 21.8 per cent. While the difference is not solely due to the adoption of the universal meter system, it is largely attributable to this cause. There was a reduction in the fuel consumption, also, and about 60 per cent. of the new meter takers paid less than formerly under the fixture rates. Of the remaining 40 per cent., few exceeded their previous fixture rates. Leakages usually accounted for large bills. About one hundred new supplies were added to the system, but the total amount of water consumed was 13.5 per cent. less than in the preceding year's corresponding period.

Some British Sewage Disposal Apparatus.

The accompanying illustrations show three examples of sewage distributing apparatus recently installed in England. The first is at Hollymoor, where a continuous filter has been built as a part of the extensive works which are under construction by the Birmingham, Tame and Rea District Drainage Board, whose chief engineer is Mr. John D. Watson. In the issue of this journal of Dec. 23, 1905, a description of the unusual system of electric power distribution required for the works was printed, and an illustration was given of one of the continuous filters which had been equipped with an electrically driven apparatus for distributing the sewage over the surface of the filtering material. In the filter shown in the accompanying illustration the distributing apparatus is automatic and driven by the sewage itself. The distributor consists of an elongated water wheel which not only revolves on its horizontal axis but also carries itself over the surface of the filter on a roller track. The septic tank effluent is fed to the apparatus by a pipe rising in the center of the bed when the latter is circular, as in the case of this installation. The sewage falls into the buckets of the wheel, spreads itself along the buckets, and thus causes the wheel to rotate by the unbalanced weight of the liquid. As the wheel rotates the sewage escapes in a thin film from the edge of the bucket and is thus distributed over the surface of the bed.



Continuous Filter for Birmingham Disposal Works, at Hollymoor

The second photograph shows a continuous filter in course of construction at Enfield, near London. This is an unusually large bed, having an area of 0.18 acre and designed to purify 250,000 imp. gal. of sewage daily. Unlike the filter at Hollymoor which is filled with broken stone, that at Enfield is made of clinker, a material which, for some unexplained reason, is extensively used for British sewage filters, although experience shows that it is too friable and easily broken down for the purpose. The construction of the walls, with their openings for the ventilation of the bed, and the supports of the distributing apparatus are well shown in this illustration. Although this distributing apparatus is supplied for both circular and rectangular beds, the designers believe that the former type has important advantages over the other as regards simplicity of working. The motion is continuous so long as there is an ordinary flow of sewage, while even the smallest flow must fall into the buckets and produce an intermittent rotation which will cause its distribution. The arms are also fitted with balancing devices which are intended to utilize the force of any wind that may be blowing to assist the operation of the apparatus.

The third illustration shows an installation of automatic gear for controlling the operation of contact beds at Burford, in Oxfordshire. It is stated that the beds can be left for days without attention, and the gear can be set to fill the beds one at a time as soon as the previous bed is full, or alternately as soon as a definite volume of sewage has accumulated in the inlet carrier. The bed can then be left to stand full either for a given length of time or until the succeeding bed in the cycle is filled, when it will be emptied and its outlet valve will stand open for the bed to drain thoroughly.

The valves are operated in each case by a bell-shaped cast-iron float. Both valve and float are suspended by a connecting rod from a beam or lever pivoted and counter-weighted as indicated fairly clearly in the illustration, which shows the outlets of two beds in the foreground, the inlets being set at the other end of these beds. In this case the inlet to each bed is closed as soon as the bed is full by the escape of the air which holds up the bell float. There are air pipe connections between the different beds for controlling the inlet valves. In other cases there are water connections. The air connections allow one bed being at a different level or at a considerable distance from other beds in the same cycle. Any one bed may be cut out without disturbing the operation of the others. Both the distributors and the gear shown in these illustrations are made by Messrs. Birch Killon & Co., of Manchester, England.

GERMAN EXPORT TRADE to East Africa is encouraged in a substantial way by the Berlin authorities, according to a report by U. S. Consul Hollis, at Lourenco Marquez. There is a regular line of steamers from Hamburg which draw subsidies from the German Government and has arrangements with the German railways so that through bills of lading are given from inland cities in the empire to the African ports. In consequence of such excellent transportation facilities the German trade is steadily increasing.

The Selection of Portland Cement for Concrete Blocks.

A paper read before the National Association of Cement Users by Richard K. Meade, chief chemist of the Dexter Portland Cement Co.

In every new industry there are some successes and many failures. The concrete block industry has been more fortunate than most new industries, in that a heavy demand for building materials of all kinds has made the number of failures less than the number of successes. Whether this condition will last will depend entirely upon the class of work done by the present generation of concrete block manufacturers. If their work is good, if their product proves sightly and buildings made of it turn out to be enduring and sanitary, the failures of the future will be few, and will depend wholly upon a disregard of the law of supply and demand, or an ignorance of the business. If the work of the present generation is poor, if buildings built of its product are unsightly, damp and given to decay and ruin, the failures of the future will be many and will, of course, be directly attributable to the poor work of the present day manufacturers.

A general impression seems to prevail that sand is of many grades and must be carefully selected to give a block of good color and the requisite strength. Likewise, that each make of concrete-block machine possesses features peculiar to itself which will add to the economy with which the factory can be run or the quality of its output. Portland cement, however, is thought to be Portland cement, and like Caesar's wife, to be beyond reproach. One brand is often considered as good as the other, and the whole selection often turns on a difference in price of a few cents a barrel. A sales agent for a large cement plant recently said to me, "My friend, there is no such a thing as bad Portland cement," which was another way of saying that "there is a sucker born every minute," and, if a cement is not good enough for the careful purchaser who tests his purchase, it can readily be worked off on the careless man who does not.

The concrete block manufacturer needs the best of cement, and the future of his business will depend upon his getting this. If he allows his warehouse to become the dumping-ground for cement rejected for such heavy, rough undertakings as piers, abutments and foundations, how can he expect the finer and more exacting class of work which he does to last.

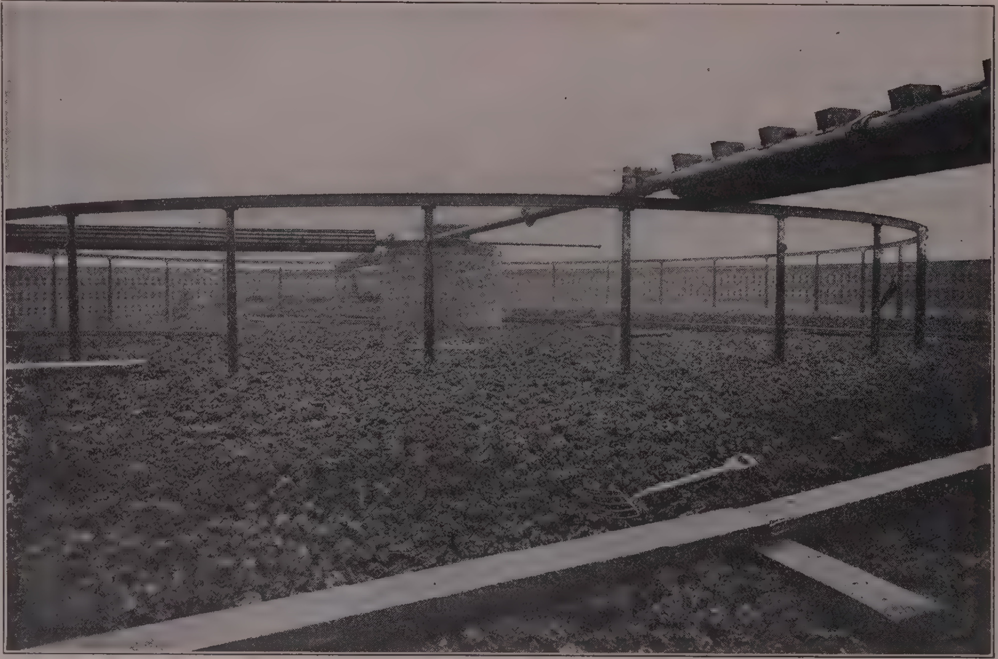
It is the purpose of this paper to point out the properties most requisite in Portland cement to be used for the manufacture of concrete blocks. Three all-important qualities of the latter will be dependent upon the cement of which they are made; two of them will be entirely dependent upon it and the third to some extent. These properties are, (1) endurance, (2) strength, and (3) color. The endurance of the block is, of course, an important property, as it makes little difference what strength the building may have when made if in a short time it is to disintegrate. The strength of the block, however, should be such that it will withstand all stresses, strains and loads which may be applied to it, either in the laying of it in the wall or after it is in position and the building completed. The color of the block affects its marketability for superstructure work. To take up the way of attaining these qualities in detail, we will first turn our attention to endurance.

Endurance.—To manufacture concrete blocks which will last and which will retain their strength in spite of the disintegrating action of time, water and the gases of the atmosphere, a "volume constant" or "sound" Portland cement must be used. What causes certain cements to swell and expand after mixing with water and allowing them to harden is not certainly known. Those conditions surrounding the manufacture of cement which give it this tendency are well understood, however, and are usually improper proportioning of the raw material (allowing the lime to be in excess over the silica and alumina) and insufficient grinding and burning of the mixture. This has led most cement investigators to attribute disintegration to an excess of "free lime." This free lime is locked up in a case of hard cement clinker and is almost as effectually protected from water when the cement is made into concrete as if it were sealed up in a bottle. In time, however, the hard protecting case of clinker is itself acted upon by the moisture of the atmosphere and other influences, and becomes hydrated. The water then has a chance to get at the free or loosely combined lime, and this, in hydrating or combining with the water, expands with great force and disintegrates the now fully hardened concrete; just as water freezing in an enclosed vessel will burst the container no matter what its strength may be. This is the most common explanation of the "blowing" or expanding of unsound cement, but be the reason what it may, it is a fact that such Portland cement sometimes expands to such an extent after hardening that the expansion may even be measured and blocks of concrete made from such cement will sooner or later fall to pieces and disintegrate.

Certain brands are much more liable to this tendency than others. Some mills are provided with insufficient grinding machinery for the raw materials and can, therefore, seldom make a cement which is sound when fresh. These depend on seasoning to make their product sound, and, hence, when pushed for orders, are very apt to ship fresh and consequently, for them, unsound cement. Lack of knowledge or of skill in manufacture or of system in supervising the process often are the causes of unsound cement. It is probably easier to make a sound cement from cement rock alone than from any other material and next to this comes the cement-rock-limestone mixture, the difficulty with this growing greater as the percentage of limestone in the mixture increases. It usually costs less to make an unsound cement than a sound one, because less care is needed in proportioning the raw materials, less grinding is necessary to prepare them for the kilns and less coal may be employed in burning them. Consequently, the block manufacturer should exercise care in purchasing cement to make sure he does not secure cheaply or carelessly made and consequently often unsound cement. If he does secure such a cement, the result will be this: His blocks when freshly made and after "curing" will be sound and hard, and will present no sign of the dissolution, which may ultimately take place with them. They will go out and be laid in the wall of a house. In time, possibly in a year, may be more, the face of the blocks will begin to crumble and strip off the blocks, cracks will appear in them, and, if the cement was very unsound, the blocks will eventually crumble away. This is no exaggeration. I have seen briquettes made of three parts sand and one of unsound Portland cement, the proportions often used in block manufacture, which, when hardened for a week. stood a tensile strength of over 350 lb. to the square inch, yet in less than a year had fallen to a powder in which almost every grain of sand was separate and distinct and the cementing agency which had at one time bound them together was merely a mass of light brown powder.

Unsound cement is by no means a rare occurrence either, and there are manufacturers who believe "no cement is bad" and ship fresh from their grinding mills any old thing they happen to be making, whether it passes standard "soundness" test or not. The cement inspector of a large corporation recently told me that 90 per cent. of the cement offered his concern by a certain manufacturer was rejected because of its failure to pass the soundness tests. Are you certain that you did not get any of this cement? I know that cement tests are expensive, yet I know of no better safeguard against unsound cement than the laboratory test. The next best thing is confidence in the knowledge, skill, care and good faith of the manufacturer himself. The concrete block made of unsound cement differs in no way perceptible to the senses from those made of sound. It may not distintegrate for years, it may, indeed, for that matter, never disintegrate, but the chances are that the blocks made of unsound cement will sooner or later crack and crumble, and the concrete block industry in the sections in which this does occur will very likely receive a serious set-back thereby.

It is now generally recognized that seasoned cement is much better than fresh. My own experiments indicate that cement seasoned in bulk for about six months is at its best. Cement which has been kept in bags this length of time, unless stored in a very dry place may lump, however, and consequently the block manufacturer may have some trouble making a good sand mixture. There is much to be said in favor of the block manufacturer's buying his cement in large quantities and storing the same for some months. By doing this he will be much less likely to use unsound cement, since unsound cement is often cured or made sound by seasoning. The cement will also gain something in strength. Two objections to storage are the liability of the cement to lump or cake and the possibility in some cases of its becoming quick-setting. The latter tendency is usually met in low-limed and poorly manufactured cements, though under certain conditions all cements seem liable to become quicker setting with seasoning.



Enfield Continuous Filter During Construction.

It is a well known fact to those versed in the technology of Portland cement that the addition of plaster of Paris to unsound cement often makes it pass the standard steam test; and that some manufacturers make a practice of so "doctoring" unsound cement. The addition, however, is harmful to cement, as an excess of plaster not only causes the concrete to weaken in time, but also causes unsightly white streaks and efflorescence on concrete blocks. The unsoundness caused by plaster can only be detected by long-time tests, so that the usual plan of guarding against it is by limiting the amount of sulphur trioxide found in the cement to 1.75 per cent. Since this is the active constituent in plaster of Paris, by determining the amount present, as can readily be done by a chemical analysis, we can calculate if a harmful percentage of plaster has been added to the cement.

While not strictly falling under the title of this paper, it may be well here to mention some causes of unsoundness in concrete blocks, which are not due to the quality of the Portland cement itself, but to qualities which are developed in it by the use of certain substances, added to facilitate manufacture or give color. The demand for a quick-setting cement has brought into use the carbonates and hydroxides of potash and soda. These chemicals are the base of nearly all the quick-hardeners sold to the concrete block manufacturer. They cause unsoundness to a marked degree and should not be used except upon the advice of an expert cement chemist. They also cause efflorescence on the block.

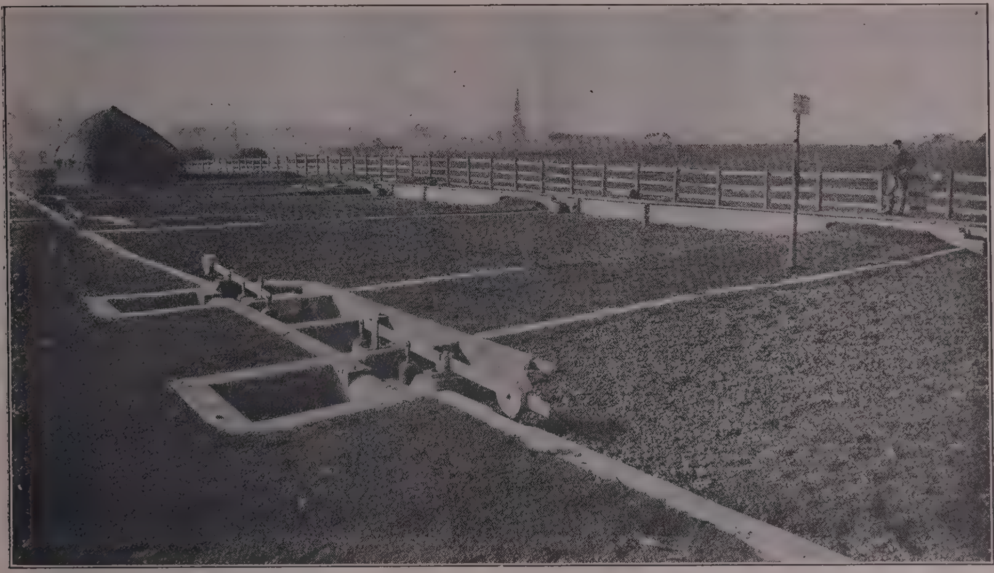
Some care should also be used to guard against coloring matters for the blocks which contain such chemicals as the sulphides or sulphates, chromates and acetates, which are likely to react with the cement to the damage of the block. Most sulphides are readily oxidized to sulphates, which change is accompanied by expansion and consequently disintegration of the block. Pure oxide colors are best and can be used with safety. Sands, with a large percentage of soda and potash minerals, such as mica, or containing pyrites, iron sulphide, are also objectionable for the reasons given above.

Strength.—The strength which Portland cement may develop is due to various conditions of its manufacture, such as chemical composition, thoroughness of burning and fineness to which it is ground. As cement is always used with sand, no attention need be paid to its neat strength unless blocks are to be faced with very rich mixtures. Neat strength is very deceptive and is seldom a reliable indication of sand strength.

One of the most important qualities of Portland cement in determining the strength of the concrete made from it is the fineness to which it is ground. Other things being equal, the finer the cement, the greater will be the strength of the concrete. Thus, a cement as ground by the manufacturer so that 95 per cent. of it would pass a 100-mesh sieve, gave a sand tensile strength of 267 lb. in 7 days, while the same cement ground to all pass a 200-mesh sieve, gave 375 lb. for the same period, or an increase of 40 per cent. in sand strength due to finer grinding.

In this connection it may be said that fine grinding seldom increased the neat test any, and, indeed, as a general thing lowers this, so that high neat tests when given without the sand tests may be regarded as meaningless. The particles of cement retained on a 200-mesh sieve are entirely inert and may be looked upon as just so much aggregate. If these particles are sieved out and the attempt is made to make a block of them it will be found impossible to get the mass to cohere. Exactly how small the cement particles must be before they will be acted upon by water no one has yet determined, but it is known that of the material passing a 200-mesh sieve some of it, at least, is not fine enough. This has an important bearing on the value of the tests for fineness. For example, a cement all of which is ground just sufficiently fine to pass a 200-mesh sieve is not in reality so fine as a cement ground in such a way that while some of it fails to pass a 200-mesh sieve, still the greater part of that which does is a more or less impalpable powder.

Similarly cement ground 85 and 95 per cent. through the 200-mesh sieve by rolls and other flouring methods of grinding is not really as fine as cement ground 75 per cent. fine by other methods.


Automatic Gear for Controlling the Operation of the Burford Contact Beds.

Since the particles of cement retained on a No. 200 sieve are inert, the purchaser may look upon all of such coarse material as so much waste matter, whose place can be taken by sand without detriment to the resulting concrete.

Probably all concrete block manufacturers are striving for a waterproof block, one in which all the voids are filled. This latter may be achieved by the use of a richer mixture, by waterproofing compounds, or preferably by the employment of a sand containing the proper proportion of fine particles. These fine particles help to fill the interstices between the coarse ones and to so keep out the water. One of the oldest principles of good concrete is "to coat the particles of sand with the cement paste," and the strength of the concrete is proportionate to the thoroughness with which this has been done. Now the finer a body is pulverized, the more surface it will present. Thus, if we divide a cube an inch square into halves, we will increase the surface area from 6 to 8 sq. in., and if we quarter it we will increase to 10 sq. in. Consequently the finer sand we use, the more surface there will be to coat and for exactly the same reason the finer must the cement be to coat this sand.

By using a sand containing fine particles and a finely ground cement in place of a richer mixture, fine cement is made directly more economical than the coarsely ground one.

By "fine cement," however, is not meant a cement ground by rolls, to show a good sieve test, but a cement which contains a large percentage of flour. Since in such a dense concrete there are no voids, or practically none, there is no room left for the expansion of the cement during hardening, as is the case with ordinary porous concrete, where the cement can usually expand a little into the spaces between the sand grains. It becomes, therefore, doubly important to use a sound or in other words a non-expanding Portland cement.

The setting time of Portland cement also has an important influence on the strength. Slow-setting cements, that is cements which get their final set in from 4 to 9 hours, are much stronger than those which set more quickly. Quick-setting cements are nearly always over-clayed and contain less of the active silicate and aluminate of lime to which cement owes its strength, than the slower setting ones. This may seem paradoxical, but it is nevertheless true. The compounds in cement which set quickly are not those which give it great strength, consequently, cements giving an initial set of less than 30 minutes are hardly ever as strong as those which require two or three hours. For example, a cement which sets in 30 minutes rarely ever, unless very finely ground, gives a seven-day sand test of over 250 lb., while one with a set of two or three hours may easily give 300 to 350 lb., or even more. Cements with a "flash" set, that is, which set up under the trowel, should not be used in making blocks, as these latter are apt to be weak. With such cements the set is broken by working, the processes of solution and crystallization are interfered with, and consequently the cement has only half a chance to do its work. The set of the cement should always be sufficient to give ample time to mix the mortar and fill the machine, or molds.

One of the greatest requisites of Portland cement to be used for concrete blocks, is that it shall be a quick hardener. It must get its strength promptly. By prompt hardening is not meant quick-setting cement. The term "set" is merely used to define the change undergone by the mortar in passing from the plastic to the solid state. The hardening only begins after the setting process is completed and quick-setting cements are not necessarily prompt hardeners, and are, indeed, usually the reverse.

The best test for prompt hardening is the 7-day sand strength. Cements which get a tensile strength of 300 to 350 lb. per square inch in 7 days are now on the market, and these are best suited to concrete block manufacture. If the blocks do not lose strength, the sooner they get their full strength the better, because the sooner they can be used, as less time is needed to cure them. A cement which has a sand strength of 350 lb. after 7 days, and which has only increased 50 lb. in a year is, to my mind, much better for the purpose than one which has a strength of 200 lb. at 7 days and increased 150 lb. in the same length of time; because it will stand the same stress seven days after making that the other one will after it is a year old. A building may have to bear its full load three months after the blocks are made and hence the more promptly hardening cements are needed for block making.

Below is an example of the two classes of cements—prompt hardeners, and those with what their manufacturers point to as a "progressive increase":

	7 d.	28 d.	3 m.	6 m.	1 yr.	2 yr.
Prompt Hardener.......	375	382	380	395	415	415
Progressive Hardener...	212	275	282	312	360	366

Cements made in the old-fashioned upright kilns are all slow hardeners, while the best rotary kiln cements are usually prompt hardeners. Upon the introduction of the rotary kiln in this country about 1890, those who still used the upright kilns in America, and the German manufacturer who used them exclusively and who also, at that time exported largely into this country, used the argument continually to keep the rotary cements out of the market, that Portland cement should show a slow progression gain for a period of ten years or more. It is interesting in this connection to remark that the German scientists must now be satisfied that prompt hardening cements are all right, since they are rapidly replacing their upright kilns by rotary kilns, and some of their leading scientists have become the champions of high-lime, prompt hardening cements.

A prompt hardening cement and a slow hardening cement can be made from the same batch of clinker, by grinding one lot coarse and the other fine. If the coarse ground is "volume constant" or "sound," it will usually give a cement which gives low tests at first and finally fairly high ones. The fine ground cement on the other hand will give tests which are high at first and increase very little comparatively with time. This shows that slow hardeners are merely Portland cements with more or less slowly acted upon material in their make-up. This material may be either coarse particles of cement or material of feeble hydraulic properties, which only begins to hydrate after a long period in water. Portland cement can also be made slow hardening by additions to it of such substances as ground slag, limestone, cement-rock, Rosendale or natural cement.

All rotary cements are not prompt hardeners, as chemical composition as well as methods of burning influence this. Prompt hardening cements usually cost slightly more to make than slow hardeners, as the former usually contain a higher percentage of lime. This necessitates finer grinding of the raw materials and harder burning to make a sound cement.

Unsound cements give high short-period tests which fall off remarkably with time until ultimately the briquettes may fall to pieces of their own accord. Prompt hardening cements often give neat tests which are high at 7 days and fall off somewhat after that period. The old theory was that this showed internal agencies at work disrupting the briquettes, but it is now generally accepted that if the cement is sound, falling off in strength of neat briquettes is due almost entirely to the fact that as the cement hardens it becomes brittle and more easily broken by the sudden jars and strains to which the briquettes are subjected in testing. Sand tests, both tensile and compressive, made of the same cement seldom show any marked falling off and hence, since cement is always used with sand and in compression or abrasion, no attention need be paid to the brittleness of the neat briquettes. Where, however, blocks are to be faced with rich mixtures, such as one of cement to one or two of sand, some attention may be given to neat tests also, or better still, special briquettes may be made using the proportions to be employed in facing the block. If the latter cannot be done, cements giving good neat tests should be employed and since unsound cements are more apt to give trouble in rich mortars than in lean, for the reason explained before, only well seasoned cement should be used. Concrete blocks are now sometimes waterproofed by coating their exposed surface with a thin layer of paraffin. This thin layer effectually protects the interior of the block from the moisture of the air, and as cement can only harden by hydration (absorption of water) the block can not gain in strength after it is so coated. Consequently, where waterproof blocks are made prompt hardening cements should be used, and the block should be allowed to gain good strength before applying the coating. For a similar reason these blocks should not be made too dry.

In connection with the use of waxes for waterproofing, it may be well to state that certain waxes and fats are very likely to decompose in time, with the formation of "fatty acids." These acids attack the concrete by dissolving out the binding agent, hydrate of line, from between the sand grains. Pure paraffin, however, does not decompose into fatty acids, but some animal fats and vegetable waxes are very likely to do so.

Color.—The concrete block manufacturer will probably be more interested in the color of his blocks than in any other one of their properties, since upon this will depend the immediate marketing of his product. Uniformity of color is, therefore, very important to him, since the color of a building in order to be pleasing should present a uniform appearance to the eye. Uniformity can only be secured by making the block of uniform cement and sand, mixed in definite proportions and manufactured into blocks under as nearly the same conditions as it is possible to obtain. For colored blocks, dark colored cements may be used, but their color should be uniform. For lighter blocks, light colored cements must be used. As the color of cement gets lighter as it is ground finer, only finely ground cements should be employed for this work. The percentage of iron and manganese in the cement also influences the color. Cements free from iron and manganese would be white, and the color darkens as the percentage of iron or manganese increases. Most cements are perfectly free from manganese, and hence the color is usually due to iron.

Sulphate of lime, which is always added to cement to regulate the set, is one of the causes of the white efflorescence seen on concrete blocks. This salt is soluble and is carried to the surface of the block by the water which "sweats" out during curing. The less sulphate of lime present in cement intended for concrete block manufacture the better. As Portland cement can be obtained which contains less than 1.5 per cent. sulphur trioxide (the chief constituent of the surphates and the way they are usually reported in a chemical analysis) it is hard to see why cement containing more than this amount should be used.

The alkalies are also soluble salts and are to some extent responsible for the saline efflorescence on concrete. Cements low in these should, therefor, be used. Most American Portland cements, however, contain less than one per cent, alkalies.

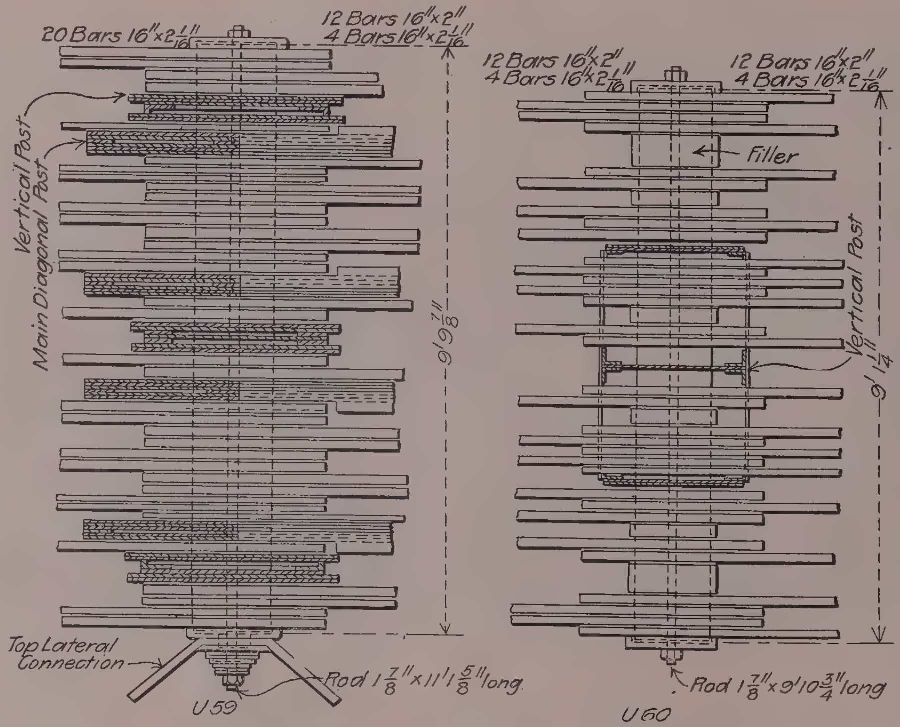
Sulphide of iron is sometimes met with in cements burned in upright kilns. This causes dirty brown splotches to appear in the work from the oxidation of the iron to brown oxide of iron or "rust." Overclayed cements also show the same dirty brown color throughout the mass, as in such cements the iron seems to be present as the red brown "sesquioxide" instead of the black "magnetic oxide" of well made cements.

In the discussion of the above paper, Mr. C. W. Boynton, chief inspector of the Cement Department of the Illinois Steel Co., stated that he hardly thought cement testing should be added to the troubles of the concrete block producer. The making of blocks is vexing enough without having it complicated by the necessity for testing the cement. Manufacturers are entirely willing to submit their cement to test, but the block maker will find that the testing is not worth while unless he entrusts it to some reputable laboratory engaged in making such tests as a regular commercial business. Mr. Boynton did not consider the danger from bad cement to be as great as a hasty reading of the paper might suggest. Any block maker who will recall the number of failures which he is certain were due to defective cement will be convinced that the features of his business demanding watching most carefully are the little details of manipulation of all the materials. Of course it is convenient to put the blame for poor results on the cement, as it is no use to blame nature for bad sand or water and it will never do to assign any defects in the blocks to the oversight of an essential precaution by the maker.

A Road Materials Testing Laboratory has been established at the University of Illinois as a part of the engineering experiment station which the State of Illinois has provided for at that university. Considerable equipment is available in the testing laboratories of the engineering department of the university for making general tests, and other apparatus for making special tests will be added. The chemical, physical and wearing properties of materials for metaling roads will be investigated, the experiments being carried on under the direction of Mr. A. N. Johnson, State highway engineer of Illinois.

Secondary Members of the Island Span of the Blackwell's Island Bridge, New York.

The design of the main vertical and inclined posts of the island span of the Blackwell's Island bridge was described in this journal on Jan. 27, and it is proposed to take up in this article some of the secondary members. Light vertical posts are riveted to the main diagonal posts just above their intersections with the main vertical posts and serve to support the weight of the top chords at the sub-panel points and to receive the connections of the intermediate sway brace frames. These subposts have 24 x 37-in. rectangular cross-sections made of four 4 x 4 x ½-in. angles, one at each corner, with their flanges turned inwards and connected by tie plates and lattice bars. Two sets of tie plates project beyond the inner face of the post to form jaws receiving the transverse struts and sway brace diagonals, which are field-riveted between them. At the top of the post there is a center longitudinal diaphragm and a vertical longitudinal web plate in the plane of each face, thus practically providing three webs. These webs are bored to engage the 14-in. top chord pin beyond which they project 3½ ft. and are capped with a field-riveted horizontal plate.



Top Chord Pin Packing at Main and at Sub Panel Points

At sub-panel points the great weight of the long sections of the lower chords between main panel points and that of the intermediate floor beams is suspended from the center points of the main diagonal posts by stiff vertical hangers. These have a 24 x 36-in. H-shaped cross-section made of a ½-in. web plate, four 6 x 4 x ½-in. flange angles and two 24-in. flange plates, stiffened with a vertical flange angle on each edge. The foot of the hanger has an extended base field-riveted to the bottom chord through long horizontal angles. A 2 x 14-in. slot is cut through both flanges near the foot of the hanger, and through it are passed the two 13 x ½-in. tension bars which unite the top flanges of the floorbeam and cantilever bracket and are field-riveted together on opposite sides of the hanger web.

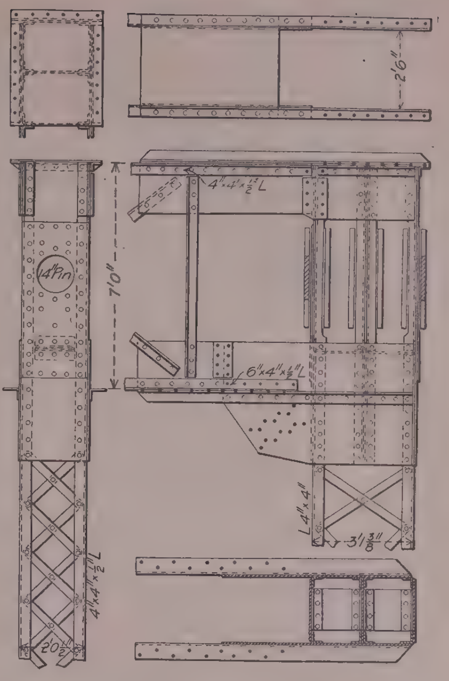
At the upper end of the hanger a pair of ¾-in. gusset plates, 67 in. wide and 13 ft. long, are shop-riveted across the flanges and project beyond them on one side to form jaws between which are field-riveted the vertical diagonal and horizontal members intersecting at the center of the truss panel. These plates are also bored to receive the 15-in. C-pin and transmit the load on the hanger to it and to the main diagonal post. Smaller jaw plates below it receive the transverse bracing, and a seat projects 21 in. beyond the outer face of the hanger to receive the sidewalk bracket, like that on the main vertical post, described in the article printed on Jan. 27. There are in all 18 hangers required for the island span and each is marked with the letter H and the panel number, as H62.

The packing of the chord pins was a very difficult and important matter and occupied a skilled designer several weeks. All main pins are of nickel steel with an ultimate strength of 90,000 lb. and are for this span chiefly 14, 15 and 16 in. diameter and from 7 ft. to nearly 10 ft. in length. The largest weigh about 7,000 lb. each. They are turned and polished to a clearance of only about 1/50 in. in the eyebar and post holes. Each has a 2-in. hole through the axis to receive a 1⅞-in. rod with a nut at each end which secures the pressed steel cupped disk covering the end of the pin and taking the place of a pin nut. At the main panel points these rods project beyond the disks on the insides of the trusses and their nuts secure washers which are screwed tight against the connections for the eyes of the top lateral rods.

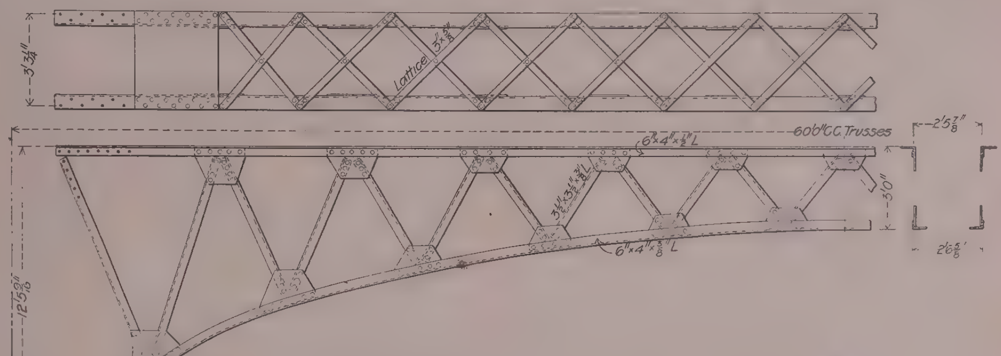
An allowance of 1/16 in. is made for clearance for every piece assembled on the pin, counting each bearing of a compression member as one piece, and any excess in the thickness of each eyebar is assumed to come within this allowance. The eyebars are required to be arranged so that they do not diverge from a vertical plane more than 1:100. Every effort has been made to reduce the pin moments, which have finally been brought to a maximum of 19,000,000 inch-pounds, some of the preliminary arrangements having given as much as 28,000,000 inch-pounds. The extreme fiber stress of the pins is 48,000 lb. One of the most elaborately packed pins is U59, where the longest vertical and diagonal posts intersect. This pin receives, as shown in the sketch, seven web bearings, and 36 16-in. eyebars, most of them 2 or 2 1/16-in. thick, with heads 37½ in. in diameter, besides two top lateral diagonal rods.

The sway bracing between the vertical and sub-vertical posts consists of one or more panels of X-bracing in the vertical transverse plane and of two horizontal struts, all riveted members with field-riveted connections to jaw plates or web angles on the vertical posts. The top struts are all of a nearly uniform depth of about 8 ft. and have rectangular cross-sections with a single angle at each corner and latticed vertical and horizontal sides. They are virtually made with pairs of light lattice girders with single intersection diagonal angles, and have their top and bottom flange angles latticed together with flat bars, with one rivet at each end and at each intersection. The ends of the bottom flange angles are field-riveted to web plates projecting from the vertical posts. The extensions of the top flanges are field-riveted across the post cap plates, and end vertical connection plates are spliced to web connection plates on the posts.

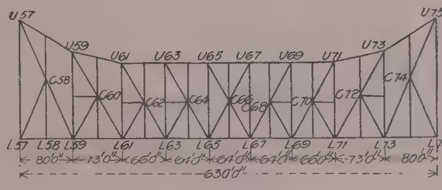
The top struts at the main panel points are heavier than those at the sub-panel points and are made of 4 x 4 x ½-in. flange angles reinforced with 8 x ½-in. horizontal plates, to which the lattice bars are riveted. The two girders in each strut are about 38 in. apart on centers. At the intermediate panel points they are made of single 6 x 4 x ½-in. flange angles without reinforcement bars, and have 3½ x 3½ x ⅜-in. diagonal angles. The lower transverse struts are also made with pairs of light lattice girders, but are of quite different design, their top flanges being horizontal and their bottom flanges curved to give a graceful, portal-like effect. The lower struts at 58 and 60 have a width of 3½ ft. over all, a depth of 3 ft. at the center and 12½ ft. at the ends, thus giving the lower flange a rise of 9½ ft. The flanges are made of single 6 x 4-in. angles with the horizontal legs in the upper flanges turned out and those in the lower flanges turned in.



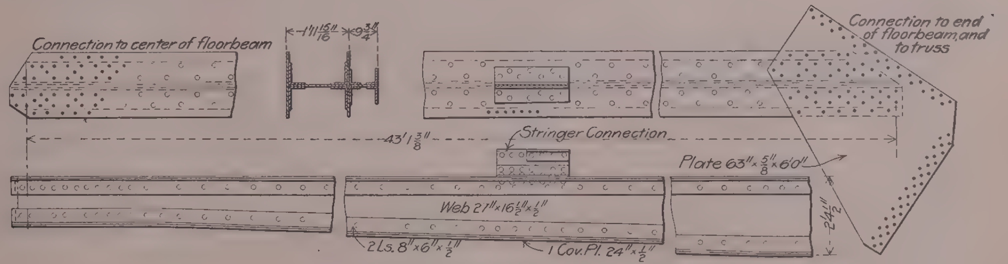
Sub Vertical Post and Upper Transverse Strut Connection.



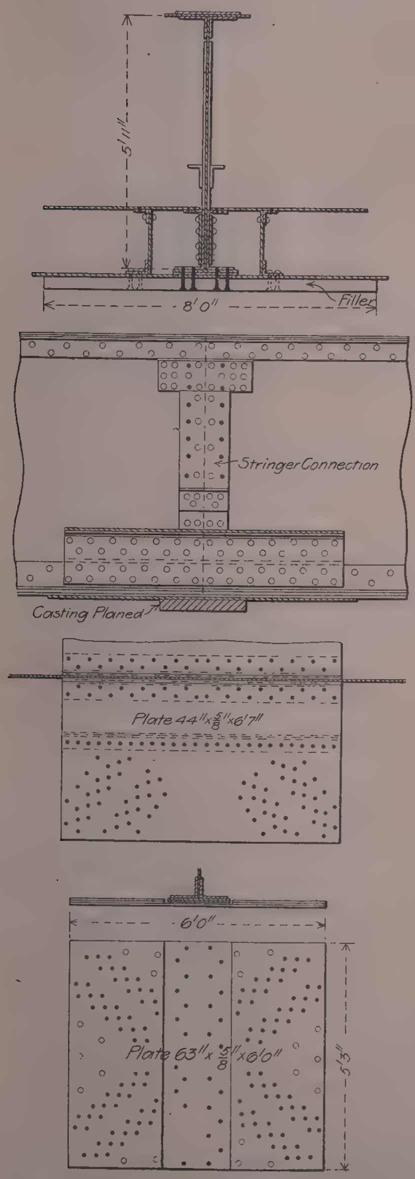
Lower Transverse Strut.



Island Span.



End Lower Lateral Diagonal.



Connection for Lower Lateral Diagonal to Middle of Floorbeam.

Zigzag 3½ x 3½ x ⅜-in. web angles connect the flange angles. Connections to the vertical posts are field-riveted through the ends of the top flange angles and through the end lower flange connection plates.

Two panels of X-bracing are provided between the top and bottom transverse struts. The diagonals are all of uniform construction, with I-shaped cross-sections 2 ft. deep made of two pairs of 7 x 3½-in. angles with their 3½-in. flanges riveted together with flat vertical lattice bars between. At intersections the flanges are mitered and riveted between splice plates, with their edges cut concave between the struts. At the outer ends the flanges are field-riveted between jaw plates on the vertical posts.

The lower lateral diagonals are in the horizontal plane of the floorbeams, and each X-brace strut crosses one full-length main panel of the bridge, intersecting at the center point on the axis of the bridge with the opposite diagonal and with the web of the intermediate floorbeam. The end diagonals have an I-shaped cross-section, made of a solid web plate, four flange angles and two flange cover plates. The web plate is ½ in. thick and tapers from 18 in. deep at the ends to 27 in. at the center. The flanges are made of pairs of 6 x 8 x ½-in. angles. Their 6-in. legs have one row of rivets through the web, and the 8-in. legs have two rows of rivets through the 24 x ½-in. cover plates. At the ends the flanges are field-riveted between pairs of horizontal jaw plates and at the intersections one corner is beveled and they are riveted between pairs of 63 x ⅝-in. x 6-ft. horizontal connection plates. The lower plate is field-riveted across the bottom flange of the floorbeam and the upper plate is made in two pieces, which are riveted to opposite sides of the floorbeam web. In the center panels of the span the lighter struts are made of a uniform depth of 28½ in. and have pairs of flange angles riveted together back to back and latticed. In all cases bearings are extended a few inches above the top flanges of the struts to engage and be field-riveted to one line of stringers on each side of the bridge axis. All lateral diagonals have sufficient strength as girders to support their own weight without deflection, and are shipped in half-lengths, field spliced by numerous flange rivets.

The design and erection of the bridge has been under the direction of the Department of Bridges of New York, Mr. James W. Stevenson commissioner, Mr. O. F. Nichols and Mr. R. S. Buck, respectively chief engineer and consulting engineer until recently, and Mr. J. D. Wilkens engineer in charge. The contract for the manufacture and erection was awarded to the Pennsylvania Steel Co.

The details of the superstructure for the island span have been illustrated in The Engineering Record of March 4, May 20, 27 and June 10, 1905, and Jan. 6, 1906.

Impact Tests of steel are discussed at some length in "The Engineer," of London, by Capt. Riall Sankey, who is of the opinion that they deserve more general attention than has been given to them. "The variation in the results obtained with the same steel," he says, "are undoubtedly considerable in any case, and are apt to scandalize those who are accustomed to quote tensile tests to the first or second place of decimals. The writer is not prepared at present to give any reason for these variations, but he knows that, notwithstanding them, those who have made a sufficient number of impact tests are prepared to rely on them as being a good guide to the quality of steel." This opinion is in line with the general belief of American engineers who have studied such tests carefully.

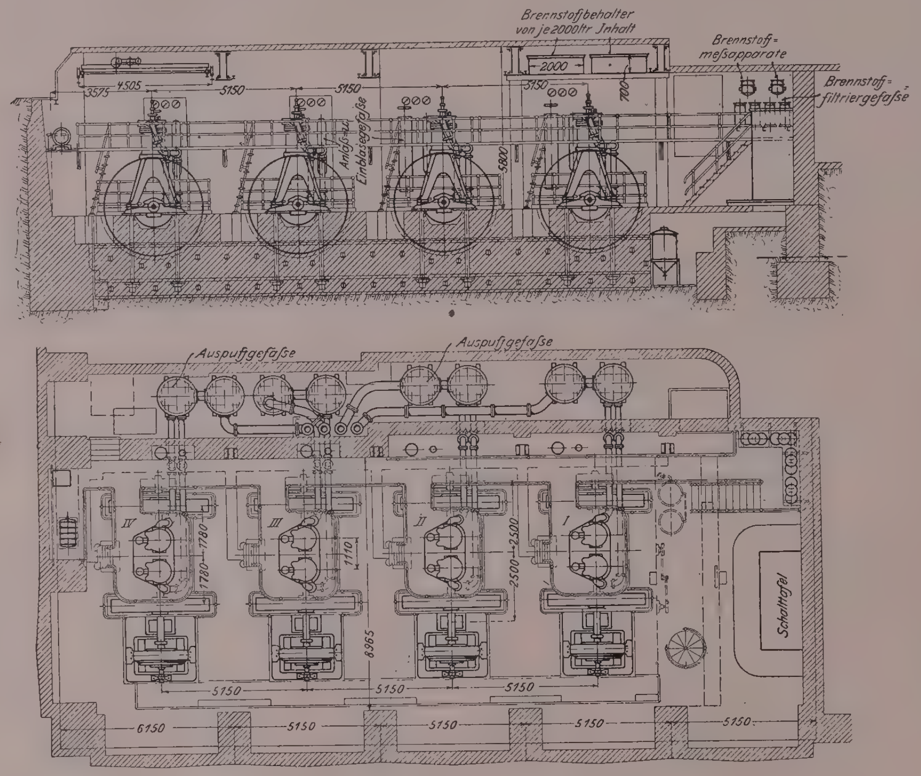
The Mechanical Plant in the Tietz Store in Munich.

About eight months ago Messrs. Heilmann & Littmann, of Munich, completed a large store for Mr. Hermann Tietz, in that city, which contains a number of unusual features. The business to be conducted is in textile goods, which led the owner to pay special attention to both fire protection and illumination. The structure occupies a small city block of 3,800 square meters, and has a basement, ground floor, four upper stories, and a steep-pitched roof. It was a foregone conclusion from the outset that the mechanical plant should use electricity as far as possible, but the best method of procuring current was in doubt for some time. The owner decided that the cost of current purchased from the municipal central station would be too great, and a private plant was accordingly necessary. It was finally determined to use Diesel engines, which had previously been selected for five large warehouses and, after some controversy with the local officials, permission to install such a plant was finally obtained. The following notes and illustrations of it are taken from an article in the "Zeitschrift" of the Society of German Engineers, written by Mr. Julius Weil.

The power plant is located in a corner of the basement. There are four Diesel engines, each rated at 200 h.-p. and having 20 per cent. overload capacity. They run at 160 r.p.m. and drive 132-kw. direct-current generators furnishing 220-volt current. Three of these units furnish current for the lighting and elevator service and the fourth is in reserve.

Each engine has two cylinders of 450 mm. diameter and 650 mm. stroke, and the crank shaft receives an impulse every revolution. There are two heavy flywheels and the variation in speed of revolution is 1/140. The engines are started by compressed air, which is stored under a pressure of 50 to 55 atmospheres in four steel flasks, each holding 330 ltr. These flasks are cross-connected so that any one of them can be used in starting any engine. The fuel oil is blown into the cylinders by compressed air, stored under about 50 atmospheres pressure in four steel flasks, each holding 85 ltr. All these flasks were officially tested to 100 atmospheres pressure, and are placed in recesses in the wall of the engine-room as indicated by the words "anlass u. emblassegefässe" in the elevation of the engine-room. The compressed air is supplied by two compressors forming a part of each unit.

For fuel a distillate from brown coal is used. It has a specific gravity of 0.88 to 0.9, a heating value of about 9,800 calories per kilogram, and a flash point of 133° Cent. About 2 cu. m. of this oil are used daily, and only a day's supply can be kept on the premises. It is delivered from the tank cart which brings it to the building into the two tanks, marked "brennstoffbehälter" in the illustrations, by an electrically driven pump. Special precautions have been taken to protect these tanks from any danger of fire. From them the oil is piped through meters, "brennstoffmessapparate," to filters, "brennstofffiltriergefässe," and then to the engines, this part of the apparatus being so planned that the supply to each engine is metered and filtered independently.



Diesel Engine Plant in a Munich Store.

Each motor has two muffling tanks, marked "auspuffgefässe" in the drawings, which are placed in a vault alongside the outer wall of the engine-room. The exhaust gases rise from them through vent pipes rising 27 meters to outlets above the roof. As a result of the complete combustion these gases are almost odorless, invisible and free from residue.

The cooling water for the cylinders is taken from the city mains and discharged into the city sewers. The amount required is about 10 ltr. per horse-power-hour, with an initial temperature of 10° C. and a discharge temperature of 70° C. In this particular case the discharge temperature of the cooling water is not permitted by the city ordinances to exceed 30° C., so that the amount required is increased to 30 ltr. per horse-power-hour. In order to control the temperature of discharge of the cooling water a thermometer with an electrical annunciator is built into each engine cylinder, which shows on a board the number of the cylinder at which the temperature has risen.

The engines are provided with a central oiling system. The oil is collected, automatically purified and then employed over again.

In order to make the attendance of the engines as easy as possibly a gallery has been built connecting all of them.

The four engines stand on a single block of concrete, which rests on iron felt made by the Arlershofer Eisenfelzfabrik, in Arlershof, near Berlin. The base is separated from the walls by air slits, which have to be omitted in but few places. Where these touching faces cannot be avoided they are made of corkstone furnished by Gruenzweig & Hartmann, Ludwigshofen. In this way all vibrations of the earth are completely avoided.

The engine-room is ventilated by means of a fan in the ceiling which is driven by a 3-h.-p. electric motor. It sucks fresh air through the windows of the engine-room, and discharges it through two openings into the vault containing the muffling tanks, from which it escapes through the duct containing the vent pipes. Noises, odors and other inconveniences due to the power plant are in this way completely avoided in other parts of the building.

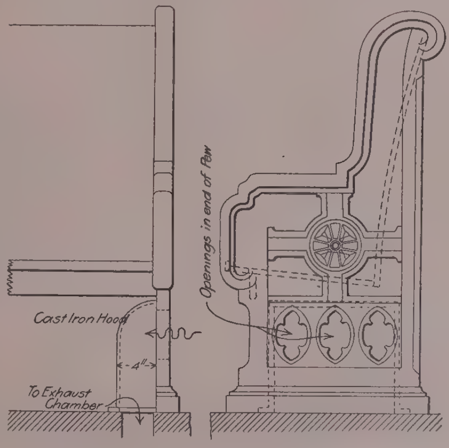
A storage battery of the Tudor-Hagen type has been provided to supplement the generating units and smooth out the great variations in the demand for current which occur where elevators are employed. In addition to this battery a connection has been made with the mains of the municipal electric lighting system. The maximum available current for power purposes is 528 kw. from the generating units, 142 kw. available for three hours from the storage battery, and 110 kw. from the municipal connection, making a total of 780 kw. Since the maximum demand is about 650 kw. it is evident that one of the units can be kept in reserve.

The switchboard has six panels, four for the units, one for the storage battery and one for the distribution. On account of the uses made of the space in the basement the storage battery must be placed about 50 m. from the switchboard, and it is accordingly provided with an automatic cell-switching device on both the charging and discharging sides. All of the meters, safety devices and switches are placed on a board behind the main switchboard, and from this point 23 service lines are run to different parts of the building. These main lines are all in loricated conduits placed in the heating flues and in separate ducts. Each line is provided with means for measuring the current flowing in it.

In designing the lighting equipment the most important question to determine was the character of the illumination of the salesrooms. On the one hand it was desirable to keep the cost of operation as low as possible, and on the other hand it was necessary to furnish a light which would show the colors of the cloths in the same tints that are seen by sunlight. It was also necessary to provide a good uniform distribution of the light. On account of these considerations it was impossible to adopt the ordinary incandescent lamp, and a choice had to be made between arc and Nernst lights. The latter was finally adopted, mainly on account of its mild glow and the graceful shape of the lamps themselves. This is the first large installation of Nernst lamps in Munich. For the other portions of the building incandescent, arc and Nernst lamps have been adopted as seemed most desirable. For the illumination of the salesrooms 2,296 Nernst lamps were employed, 48 flaming arc lamps were used in the show windows and entrances, and 1,880 incandescent lamps on the front of the building. For the offices and warerooms 940 incandescent lamps and 44 arc lights were used.

The salesrooms are divided into bays of about 25½ sq. m., and in each bay are two Nernst lamps of 1 amp. and four of ¼ emp. In this way an illumination of 15 c.-p. per square meter with a current consumption of 26 watts is attained. The building has a large central light court and on its walls at the level of the third floor there is a crown of 170 Nernst lamps. At the second floor there are 10 groups of 5 large Nernst lamps each, and on the ground floor there are 14 of these lamps. Particular attention was given to the exterior illumination of the building. The windows are provided with rows of incandescent lamps, the total number used for this purpose being 1,880. Each one of them can be switched on independently of the others. The individual distribution boards for all lamps are placed in the vicinity of the stairways so as to be readily reached. The continuously burning lights are entirely independent of the others and can only be turned on and off at the switchboard of the chief engineer in the engine-room.

The building has a telephone system with thirty-two stations. There is also a system of electrically regulated clocks throughout the building, which is controlled by a master-clock in the private offices. There are two independent systems of fire alarms. Throughout the building there are thirty-two fire annunciators connected with a private fireman's room in the basement and a central office on the fourth floor, so that the presence of fire in any part of the building can be announced in both of these places without attracting any attention. In case a severe fire should suddenly break out a general fire alarm system will ring bells at 23 places throughout the building. This is operated by simply breaking the glass cover of any one of the signals.



Details of Vent Hood Under Seats.

The electric elevator equipment consists of six passenger elevators, four freight elevators and one high-speed package lift. The passenger elevators are designed to carry 12 persons at a speed of 1 meter per second, and the freight elevators are designed for a load of 1,000 kg. at a speed of 0.6 meter per second. The building is heated by a low-pressure steam system and there is also an electrically driven hot-blast system supplying 45 cu. m. of warm air per hour to the different floors. The apparatus has been designed to maintain a temperature of 20° C. under any conditions of outside temperature. An interesting feature of the heating apparatus is a line of pipe under the overhead glazing of the light court. This is provided to melt snow falling on the glass, which would otherwise interfere with the illumination.

THE HOUSES FOR WORKMEN at Essen pay but 2 per cent. on their cost, in addition to maintenance, taxes and repairs, but this profitless investment is believed to have been very influential in reducing troubles from strikes. The owner of a large mill recently told U. S. Consul Harris at Chemnitz that had he $250,000 available for the purpose he would gladly introduce the Krupp housing scheme in the textile districts of Saxony, where nothing of the sort has yet been done.

Heating and Ventilating the Main Auditorium of the Broadway Tabernacle, New York.

Paper read before the American Society of Heating and Ventilating Engineers by C. Teran.

The heating and ventilating of a church auditorium has always been an interesting problem, for there are conditions found, and difficulties to overcome, in an auditorium of this kind that do not occur in the ordinary building, such as large glass surfaces, which are the source of cold drafts, little floor space, for placing radiators, the necessity of placing radiators near seats making these seats undesirable.

In this case there was one difficulty to contend with, namely, that under the auditorium there is a hall, which had to be left free of pipes and other objectionable features from an esthetic point of view; in other words, there is no cellar in which pipes and ducts could be placed. A space between the auditorium and the ceiling below was provided for this purpose. This space is about three feet deep, but as it is due to the depth of the girders that carry the floor its usefulness for placing pipes and ducts was limited, as can readily be understood.

After carefully considering all these points it was desired to use the blast system of heating, with mechanical exhaust and automatic temperature control for the auditorium, and direct radiators controlled by hand for the vestibules.

The blast system was considered the best in this particular case for the following reasons:

First—Low cost of installation.

Second—The objectionable radiators are done away with.

Third—From a sanitary point of view the fact that the place cannot be heated without at the same time ventilating it.

Fourth—Even distribution of heat.

The seating capacity of this auditorium is 1,500. The apparatus was designed to supply 25 cu. ft. of air a minute per person to 1,600 persons, or a total of 40,000 cu. ft. of air a minute.

It may be mentioned that in this case 25 cu. ft. a minute per person was about the maximum amount of air that could be introduced without causing drafts and noise, and this by introducing a large proportion of the air through top inlets. The entire use of bottom inlets would have been impossible without causing drafts, or considerably reducing the amount of air supplied.

A three-quarter housed centrifugal fan is used to supply the air. This fan has a blast wheel 9 ft. in diameter by 4½ ft. wide, and is driven by a direct connected motor. The fan is calculated to deliver 40,000 cu. ft. of air a minute at 130 r.p.m.

The heat transmitted through walls, windows, etc., was calculated to be 340,000 B.t.u. per hour, with 70° difference between the inside and outside temperature. Given these conditions, the incoming air would have to be heated to 78° F. to supply this loss. This is accomplished by drawing the air through a heating stack, consisting of ten two-row sections, or coils, of the miter type. These coils are built in staggered rows of 1-in. pipe, and the stack contains 7,500 lineal feet. Each section has two steam and one return connection

The air is taken from a court at the ground level, and for this reason the intake was made large, to insure a low velocity of the air in the immediate outside vicinity. This opening is fitted with a wire screen and louver damper. Through this opening the air is directly admitted to the filter room. The filter is of the "V" type, made of galvanized iron, with removable wooden frames, covered with wire and cheese-cloth in the usual manner. The filtering area is proportioned to allow 32 cu. ft. of air a minute to pass through every square foot of filtering material.

From the filter room the air is induced through the heating stack into the fan, then discharged by this into the distributing ducts and flues, leading to the auditorium. The velocity of the air is reduced in the ducts to 1,900 ft. per min., and in the flues to 900, and finally discharged at 600 ft. per min. through the top registers and 200 through the floor registers.

The heat registers are placed from 8 to 12 ft. above the main auditorium and gallery floors. There are also heat registers in the floor in front of the large windows, and in the step risers of the front gallery. The air discharged by the registers in front of windows is intended to counteract the cold air drafts produced by these cooling surfaces. A large proportion of the air is introduced on the same side as the pulpit, so that its travel is in the same direction as the voice of the speaker, thus aiding, or at least not interfering with the acoustics of the auditorium.

The equal distribution of the air is obtained to a large extent by the location of the exhaust openings. Each pew end on the main floor has an opening near the floor, forming part of the design of the ends of the pews, these openings are connected with the space underneath the auditorium before referred to, which is also used as an exhaust chamber. The connections between this chamber and the openings in the pew ends are made by cast-iron hoods, placed against the inside of the pew ends, and covering both the opening in the pew end and that in the floor leading to the exhaust chamber. These hoods are provided with controlling dampers, to regulate the flow of air through them.

The exhaust chamber is connected at one end to a Blackman exhaust fan 6 ft. in diameter. This fan is driven by a direct connected motor and discharges into the open air. It is intended that when this fan is revolving at 300 r.p.m. it will exhaust 32,000 cu. ft. of air a minute, or 80 per cent. of the amount supplied by the blower.

When the apparatus is started in operation the air is introduced at as high a temperature as the heater coil will heat it, until the temperature in the auditorium has reached the maximum required, then the air is introduced tempered only until the temperature in the auditorium falls below the normal, when the air is again heated to a higher temperature to supply the loss.

This is accomplished automatically by thermo-pneumatic control, as follows:

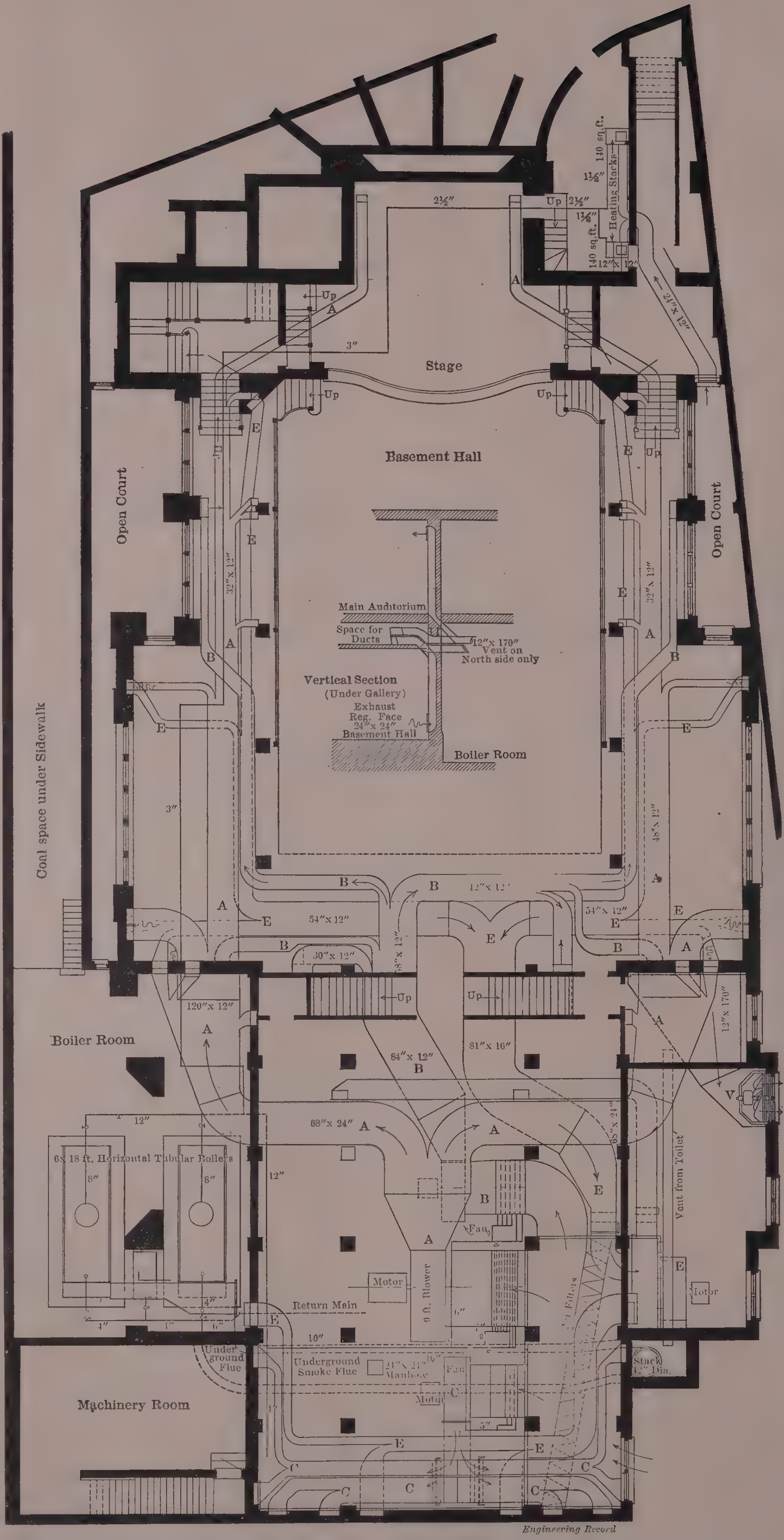
Three sections of the heating stack have separate steam connections and are controlled by a thermostat placed in the cold air chamber. This thermostat is set to operate at a temperature a few degrees above freezing, about 40° F.

The rest of the heating stack is controlled by two thermostats, one placed in the auditorium and set to operate at 65° F., and the other in the main warm air duct, also set to operate at 65° F. Both of these thermostats operate the same set of valves, controlling the inner seven sections of the heating stack.

The thermostat in the duct, however, is so connected that it can only act when that in the auditorium has operated to shut off heat, during which period of time it will maintain the air at the temperature at which it has been set. By this arrangement the same stack is alternately used as a heating and tempering coil.

In this, as in all other auditoriums, the heating apparatus is shut down until a short time before audience is admitted. On this account there is a desired advantage in having the tempering and heating coils combined in one, for when heat is turned on the whole stack is active until the required temperature is attained in the auditorium. This makes the period of heating up shorter than it would be if the tempering and heating coils were separate.

The apparatus has been in operation for some



Basement Plan, Broadway Tabernacle, Showing Arrangement of Heating and Ventilating Equipment.

months, and although weather conditions have not been favorable for an exhaustive test, the tests that have been made show that it gives the desired results.

In addition to the information afforded in the preceding paper The Engineering Record would add that the plant was designed and installed by Messrs. Walker & Chambers, of New York, of which firm the author is engineer. The 9-ft. centrifugal fresh air blower and the heating stacks were supplied by the B. F. Sturtevant Co. For the temperature control of the tempering and heating coils, the Johnson system was used. The Blackman disc exhaust fan was built by Howard & Morse, New York, and both blower and exhaust fan are driven by C. & C. electric motors.

Notes on the Office System of the Chief Engineer of Streets, Chicago.

A paper read before the Illinois Society of Engineers and Surveyors, by Mr. J. B. Hittle, Chief Engineer of Streets, Chicago.

The Chief Engineer of Streets of Chicago is independent of the other engineer officers of the city and reports directly to the Board of Local Improvements, which consists of five members, four of whom are appointed directly by the Mayor, and a secretary who is ex-officio a member by virtue of being Superintendent of Special Assessments.

During the year 1905 approximately 95 miles of streets were paved at an aggregate cost of $3,500,000. The force assigned for this work consists of one chief engineer, five assistant engineers in charge of divisions who have for their help assistant engineers and rodmen, eight general inspectors, one brick tester and one cement tester. From time to time, as the work progresses, about 75 sub-inspectors are assigned to the work, whose duty it is to pass upon and direct the same as performed, with such assistance and direction as the general inspector and assistant engineer or other superior officers may give them.

From the above it will be readily seen that the chief engineer cannot give any marked attention to any individual piece of construction, but is engaged mostly in the executive part of the business. Since an improvement originates in one of three ways, by petition from the property owners to the Board, by an order of the City Council, or in the Board, such proposed improvement is referred to the chief engineer for report and recommendation, and then assigned to the proper division engineer.

If the report is concurred in by the Board, an estimate is ordered and plats are obtained from the map department for the preparation of the estimate. The estimate is itemized no more than is necessary with the decisions of the courts on the law, and generally shows the amount or linear feet of curbing to be done, cubic yards of grading and square yards of paving, all at unit prices, and a lump sum for the adjustment of catch basins and manholes together with such new catch basins and manholes as it may be necessary to be built. All of this makes an elastic sum, so that the total amount of the improvement will be multiples of $500, the object of this being to simplify the clerical work when spreading the assessment rolls into five annual installments.

Accompanying the engineer's estimate is a description of the proposed improvement, showing the limits, together with any exceptions which may be necessary, and the established grades, so that the special assessment department may properly draw an ordinance.

Upon notification from the law department that the assessment roll has been confirmed for an improvement, the department sends to the various bureaus of the city a tracer, and from the information derived, together with the amount and character of the work, the chief engineer is in a position to know approximately when such an improvement can be completed, which time is inserted and made part of the specifications. This tracer is attached to the specifications and made a part of them.

All proposals, being addressed to the Board, are canvassed by it and the figures referred to the chief engineer for tabulation and report. If three or more regular bids are received, the lowest three are tabulated on the second sheet of the tracer for the Board's information, and the chief engineer informed of its action in the matter.

After the contract is awarded the various departments are at once notified of such an award and are informed as to the time given to the contractor to do the work. The parties notified include the Superintendent of Streets, by whom all permits are issued to the public utility corporations who desire to do work on the street; the City Electrician and the Superintendent of Water Pipe Extension. A memorandum of such an award is sent to the gas companies, telephone company and electric lighting companies. On streets where car tracks are to be adjusted, the Commissioner of Public Works is notified of the award, and the companies are requested to apply to him for a permit to adjust same.

Upon the signing of the contract, its main items are put on a card form which gives the name of the street, its limits, the individual items of the contract, the total amount of the assessment, the contractor's name, the date of the contract and the time set for the completion of the work, together with the name of the engineer in charge of the work and that of the general inspector in whose district the work lies.

The number of contracts averages about 500, and these cards are constantly in use as references. Upon the completion of the work, the date of the commencement and the date it was finished, together with the final contract quantities and the length of the improvement, with a memorandum as to whether the pavement has replaced a previous pavement, is put on the card and it is then placed in a temporary yearly file and used at the end of the year in preparing the annual report and the statistical tables necessary for it.

When a contractor desires to commence operations, application is made to the chief engineer, who assigns sub-inspectors to the work. These inspectors having been furnished with a copy of the specifications, report directly and daily to the chief engineer by postal card, which report indicates the name of the street under contract, states the amount of work done that day, where performed, the total amount of work done to date and the balance to be done, together with such information as he may deem necessary, namely, whether fire hydrants, telephone or car poles are in the way of the improvement, or anything unusual which might be of interest to the department. In case of an accident, he is instructed to get all the information he can with names and addresses of witnesses and report in full concerning it; a copy of this report is sent by the chief engineer to the city attorney, so that the city may be fortified in case a damage suit is instigated against it.

If the improvement is one in which cement is used, the contractor notifies the cement tester of the location of the warehouse in which the cement he intends to use is stored, and an employee is sent for samples, taking one sample from each twentieth bag or fifth barrel, and stenciling the latter by numbers. The color of the print is changed yearly so that no cement which has been tested the previous year will be incorporated in the work. The cement is subjected to tests for soundness, fineness, setting and tensile strength both neat and with sand. If the cement is of a brand which has been used by the department, it is subjected to the seven-day tensile test, otherwise no cement is used unless the tensile tests have been extended to a year.

When accepted cement is needed upon the work, the cement tester assigns a sampler and shipper to the warehouse, who superintends and checks the cement given to the teamster, delivering to him a certificate for the sub-inspector on the street, which certificate states the date of delivery, name of the cement, the numbers and generally contains a notation as to whether the material is to be used in foundation concrete or exposed concrete. This certificate is given by the teamster to the sub-inspector and is authority for him to use the cement on the work, and he in turn sends the certificate to the cement department, where it is kept for record as to the amount of material used. Should only part of the shipment be used on one job, the inspector then notes on the back of the certificate this fact, which notation in turn authorizes the sub-inspector on the other work to accept and use the cement. There were tested during the year 1905 254,530 barrels of cement, of which 4,070 barrels were rejected. To accomplish this work the cement tester has, acting directly under him, about nine cement samplers and shippers at the height of the season.

During the progress of the work estimates are issued upon the certificate of the division or assistant engineer, and vouchers showing the distribution of the amount authorized by the division engineer are drawn by the voucher clerk and signed by the division engineer, chief engineer of streets and the other city officials as prescribed by law. The certificate of the division engineer shows the percentage of the amount of the work performed to date of issue to the total amount of the contract.

Upon the completion of the work a final estimate is issued in the same manner as the original estimate of the engineer. The certificate for the amount of the money due the contractor upon the completion of the work also has a notation showing the width of the roadway, which width, if different from the width prescribed in the general ordinance establishing the width of roadways for streets of different widths, is entered in a book containing the special roadway widths. The engineer also notes the length of the improvement in feet, and whether or not the present pavement has replaced another pavement. These notations are entered upon the index cards and as streets are finished these cards are transferred from the every day working file to a temporary index to be used at the end of the season for the compilation of the annual report, and are finally transferred to one general file.

For ready reference a Donnelly's atlas of the city of Chicago on a scale of 200 ft. to the inch is posted, using different colored pencils for different classes of pavement and marked with the year in which the pavement was completed.

Prior to the expiration of the period of guarantee on an improvement the contractor is notified in a communication to make any necessary repairs. This notification is sent about six weeks or two months before the end of the guarantee period and is usually in the form of a letter. An examination of the improvement is made 15 days before the expiration of the guarantee period, and if repairs are needed the contractor is officially notified to make the repairs within the time set in the notice. Should no attention have been paid to the above notice, the bondsmen are notified, all such notices being sent prior to the expiration of the date of the contract for legal reasons. Should the surety company not cause the repairs to be made, the Board of Local Improvements is furnished a statement to that effect, together with an estimate of the cost of the improvement, which is made the basis of the suit against the surety company.

The Self-Propelled Car of the Delaware & Hudson R. R.

In sparsely settled districts where the cost of operating a steam-drawn train is excessive, and the immediate investment of capital for an electric service unwarranted, there has arisen a need for a self-contained car which shall be independent of a feeder system and at the same time be cheaper to operate than the ordinary locomotive and train. For this purpose, the General Electric Co. in conjunction with the American Locomotive Works, at Schenectady, N. Y., has recently completed a gasoline-electric car which presents many features of interest as a proposed solution of this go-between.

The first trial run of this novel car took place Feb. 3, when a successful trip was made from Schenectady to Saratoga, N. Y., and return, over the lines of the Delaware & Hudson R. R. During the trip several important features of this method of driving were demonstrated. While the car was not designed for high speed, the average running time was about thirty-five miles an hour, and several times the car attained a speed of over forty miles an hour. The smooth and rapid acceleration were most favorably commented upon by the engineers present, as well as the complete absence of vibration which might be thought to accompany the use of a gasoline engine.

This car consists essentially of a gasoline-driven electric generator furnishing current to electric motors geared to the driving wheels and controlled by a method similar to that employed in the ordinary electric car equipment. The car in question, shown in the illustration, is of the combination type, comprising a passenger compartment, smoking-room, a baggage room, engine room, one toilet and a motorman's compartment. The car is 65 ft. long over buffers and equipped weighs 65 tons. A complete controlling equipment is located at each end of the car, one controller being located in the engine room and a similar controller in a compartment at the other end. The car has seating capacity for forty passengers, including seats for twelve in the smoking-room. In general it is built on the lines of a standard Delaware & Hudson passenger coach, and is handsomely finished. The passenger compartment is decorated in mahogany with a birch wainscoting; the smoking room in quartered oak and both the baggage and engine rooms in painted poplar. The outside of the car is painted and lettered in the standard D. & H. pattern and Gould pattern bumpers and drawbars are provided.

The gasoline engine for this car was built by the Wolseley Tool & Motor Car Co., Ltd., of Birmingham, Eng., and is considered the most powerful unit yet constructed for this class of work; it develops 160 b.-h.-p. at a speed of 450 r.p.m. The cylinders are horizontally opposed, six in number, 9 in. diameter, 10 in. stroke. All valves are mechanically operated and the cylinders are water-cooled. Hitherto difficulty has been experienced in starting internal combustion engines of this size, but in the present case this has been entirely overcome by using shells filled with black powder to provide the initial charge in one cylinder. On starting the engine, the shell is fired by a hand trigger, the whole being similar to the breech mechanism of a gun. Jump spark and low-tension ignition are both provided, current being furnished to the latter by a small magneto driven from the engine shaft.

The volatilization of the liquid fuel is produced in two carburetors which form an integral part of the engine. Each carburetor supplies three cylinders and is equipped with two float feed chambers. The chambers are identical and are of the usual needle valve type. Very flexible arrangements are provided to govern the air supply so that it may be taken from the atmosphere or from the crank chamber, or from both, according to the conditions required. The mixture is heated to the required temperature in a small chamber which itself is warmed by the exhaust. In all details the engine is very complete. The lubrication is especially so, being force feed for main bearings and pistons and drip feed for all other working parts. Gasoline is stored in steel tanks beneath the car, and the burnt gases pass through the roof into mufflers from which they exhaust into the air. The cooling system for the cylinders consists of radiating tubes, located on the top of the car. Water for cooling is contained in the engine base.

For heating the car a three-way cock is provided which by-passes the circulating water through the usual pipe heating system within the car. The transmission is electrical, consisting of a generator and standard railway motors. Current is furnished by a 120-kw., direct-connected General Electric generator designed for 600 volts. This generator is provided with commutating poles which, in connection with the method of voltage control, permits a very flexible operating system. The advantage of commutating poles is evident when it is considered that the field excitation at starting is weak, and a large current at low voltage is required to give the necessary starting torque. Owing to the peculiar operating conditions of this system, the generator, while retaining the characteristics of a shunt-wound machine, is separately excited by a 5½-kw., two-pole, compound-wound exciter working at 110 volts. This is located on top of the generator and is driven by a Morse silent chain.

The Gasoline Electric Car of the Delaware & Hudson Co.

There are two G. E. 69 motors of standard railway construction similar to those used on the Interborough Railway, New York.

For regulating the speed of the motors, as mentioned above, voltage control has been adopted; in other words, the speed of the car is governed by varying the field strength of the generator. With this method the speed of the engine remains constant after acceleration. The controller is semi-automatic, and can be set for any predetermined maximum acceleration. It is arranged for series-parallel control, the motor connections being changed from series to parallel by the reversing handle. This latter has five positions, "series ahead," "parallel ahead," "off," "series reverse," and "parallel reverse." Arrangements are provided to prevent the motor connections from being changed from series to parallel until the resistance is put into the field circuit of the generator.

Further operating details comprise a General Electric combination straight and automatic air brake equipment, and a special lighting equipment. Meridian lamps are used, equipped with holophane reflectors, the whole affording a very satisfactory system for car lighting. The headlights are supplied with 100 c.-p. incandescent lamps of the stereopticon type, one for each end of the car.

The trial trip of this car demonstrated the practicability of this equipment and was entirely satisfactory to the engineers and officials present so far as the tests indicated. The opinion was expressed that this was merely a step toward the final electrification of all service. A gasoline car would be useful in establishing a passenger traffic, but eventually the motive power for operation would be electricity.

The accompanying photograph of the car was taken after the arrival in Saratoga. The officials present from the Delaware & Hudson Co. were: Messrs. Axel Ekstrom, consulting electrical engineer; J. H. Manning, superintendent of motive power; J. W. Burdick, passenger traffic manager; James McMartin, chief engineer; J. B. Dixey, assistant to second vice-president; W. J. Mullin, assistant to second vice-president; D. F. Wait, superintendent of Susquehanna Division; E. F. Peck, manager Schenectady Railway Co., and from the General Electric Co.: E. W. Rice, Jr., technical director; W. B. Potter, chief engineer; J. R. Lovejoy, general manager railway department; J. G. Barry, assistant manager railway department; W. J. Clark, manager transportation department; E. D. Priest, A. F. Bachelder and H. G. Chataine, of the railway engineering department; F. H. Gale, advertising department.

A Central Heating Plant.

A central heating plant at Springfield, Ill., operated by the Springfield Light, Heat & Power Co., supplies about 200,000 sq. ft. of hot water radiators and 150,000 sq. ft. of steam radiators. The engines are all simple non-condensing types, as their exhaust is used for heating. There are eight water-tube boilers having a total rating of about 3,000 h.-p. Coal is procured from local mines at 70 cents a ton for screenings. The hot water heating system starts with the circulating pumps, which are arranged to force the water through six Stahl condensers, each with 500 sq. ft. of heating surface, and three fuel economizers of 3,800 sq. ft. each, all arranged in multiple. From these the water passes to two 3,000 sq. ft. Schott condensers, also connected in multiple. In cold weather the water next goes through two water-tube boilers, which are specially built so as to act as hot-water heaters if necessary, and then passes to the street mains. Attempts to operate the boilers in multiple with the other heating apparatus have not resulted successfully.

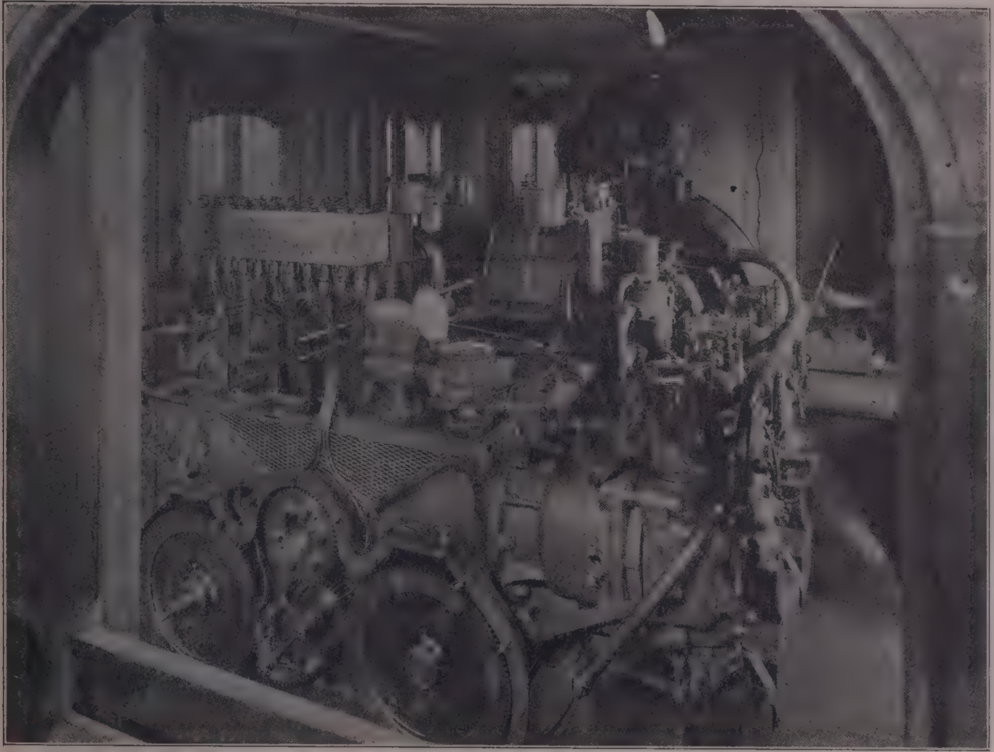
Notes on Reinforced Concrete for Columns.

By James E. Howard, Watertown Arsenal.

There are reasons for the reinforcing of concrete with steel quite independent of questions of economy in cost or facility of construction. Indeed, it appears that rich mixtures of cement mortar or concrete may be had which quite surpass in compressive strength the ordinary leaner ones aided by the presence of longitudinal steel bars imbedded therein and at a cost well within that of reinforced material.

Certain advantages lie in the direction of increased security by the proper use of steel against those unfortunate zones of comparatively low strength which are occasionally present in concrete. Inability to reach uniformity in strength in concrete under service conditions or in the laboratory is a strong incentive to reinforce with metal of such reliability as steel.

Concrete in compression may be reinforced either by the method of hooping or by the use of longitudinal bars. The two methods are dissimilar in the manner by which a gain in ultimate resistance is attained or modification in the rigidity of the concrete accomplshed.



Interior of Engine Room of Delaware & Hudson Self-Propelled Car.

Hoops reinforce concrete by providing against the lateral yielding of the material, introducing conditions similar to and approaching those which characterize loads of cubic compression. The supporting power of the concrete in this case is actually increased, the reinforcing metal not merely relieving the concrete by sustaining a portion of the load by direct compressive resistance. The maximum degree of efficiency of this method of reinforcement is reached when the hooping is continuous and of sufficient strength and rigidity to retain the component parts of the concrete in place against relative displacement, beyond a certain zone of action.

If the hooping could be made to exert an inward radial pressure independent of that caused by the lateral expansion of the column, which is incident to and accompanies the endwise compression of the material, and of such intensity as to counteract this effect, the result would be a case of cubic compression and the strength of the concrete augmented practically to an unlimited extent. Under conditions of cubic compression, provided the concrete was a dense mixture and free from voids, the stress necessary to cause disintegration would doubtless exceed our means to determine. It hardly need be remarked that no such result is likely to be realized in practical construction, but such is the possibility in respect to strength.

Tests by cubic compression made at the Watertown Arsenal, in the year 1886, furnished a demonstration of the fact that strain and not stress is the essential requisite to destroy the integrity of constructive materials. Those earlier observations have since been confirmed, to mention one instance, by subjecting a cylindrical specimen of Portland cement to a pressure of 100,000 lb. per square inch, cubic compression, without apparent injury to the material.

In practise a partial realization of the benefits of cubic compression may be expected by the method of reinforcing by hooping. Since the hoops are applied when the concrete is plastic they cannot be assembled under initial tension and will become effective only when lateral expansion has been developed by the column itself, which the hoops are intended to strengthen. The lateral expansion of a concrete column, in proportion to its endwise compression, is but a small factor and it necessarily follows that under the low working stresses usual in concrete the metal of the hooping will not be called upon to perform much work. Whether it initially does any will depend upon conditions attending the setting of the cement.

The increase in volume of the cement which accompanies hydration will need be in excess of any shrinkage of the plastic mass as a whole and occur at a period when the material has at least partially hardened in order to afford an opportunity for the hooping to acquire a state of initial tension, and thus exert radial pressure against the sides of an unloaded column. To a limited degree the resultant effect of these conditions is doubtless favorable to the introduction of slight initial strains of tension in the external reinforcement.

Hooping, however, is certainly an aid against the ultimate destruction of the concrete. However feeble its early influence may be, the hooping will doubtless sensibly restrain the material against the effect of final overloading, as this is experienced in columns with unsupported sides. In whatever degree the hooping does restrict lateral displacement the influence thereof is toward raising the ultimate strength of the concrete.

It should be recognized, in this connection, that a certain range of molecular displacement is possible in any given material without injury, but when individual parts are strained beyond this zone of action rupture necessarily ensues.

Hooping is of service in tending to keep in place the material after local disintegration is well advanced.

These are meritorious features and they give practical value to this method of reinforcement.

In the latter stages of the resistance of a concrete column the hoops will act in each capacity, above indicated. They will assist in preventing relative displacement of the individual parts beyond their zone of molecular action, and furthermore, when such range has been exceeded and rupture locally inaugurated, the hoops will still aid in keeping the parts together, in their respective places.

It is evident that the assistance afforded by the hooping will depend upon the quantity of the reinforcing metal. Since the moduli of elasticity of different grades of steel have practically the same value, it follows that strains which must be kept within narrow limits demand the liberal use of reinforcing metal, working under low stresses, rather than permitting the use of light reinforcement working over a wide range of stresses.

The degree of efficiency of the hooping will be proportional to the extent with which lateral expansion is prevented. It would seem probable, however, that the display of high efficiency might be impaired in the case of very lean mixtures of concrete. The closing of interior voids might afford an opportunity for the usual lateral expansion to expend itself, in part, within the column instead of causing the normal increase in cross-section dimensions. If this action takes place, it would constitute an argument against the employment of very lean mixtures, since it would restrict the utility of this method of reinforcement to the final stage of keeping the component parts of the column together. In any event, however, the hooping is of service in raising the ultimate strength of the concrete and therefore increasing the margin in strength over the working stresses.

Passing now to the method of reinforcement by means of longitudinal steel bars. The strength of the concrete is not directly augmented by the presence of the bars, the gain in ultimate strength and rigidity resulting chiefly, although not entirely, on account of the total load being sustained jointly by the concrete and the steel. The portion which each sustains will depend upon the respective sectional areas and the moduli of elasticity of the concrete and the steel, modified by the permanent sets which are developed at different stages of loading.

In this method the reinforcing bars are immediately available for sustaining a certain amount of load, as soon as they are built into the column, and before the concrete itself has hardened sufficiently to have acquired much strength. The bars are available for spanning over places of local weakness. The adhesive bond between the concrete and the steel permits a compensating effect to take place by means of corresponding higher stresses induced in the steel bars in the vicinity of the less resisting parts of the concrete.

A decided difference is found between the rigidity of rich and lean mixtures, more conspicuous than the differences in ultimate strengths, the leaner mixtures, of course, being the more compressible ones. It follows that longitudinal reinforcing bars will be higher stressed, at all stages of loading, in a column made of lean concrete than when used with a rich mixture. Examples may be found of steel reinforcing bars stressed with 50,000 lb. per square inch, or higher, before the ultimate resistance of the column was reached. To provide for such conditions, obviously, the steel should have an elastic limit not less than 50,000 lb. per square inch.

In considering the compressive stresses which may come upon the reinforcing bars in columns, if provision is made therefor, attention is directed to the absence in the ordinary methods of construction of what would seem adequate means for utilizing these high stresses. The bond between the concrete and the steel is relied upon to transfer to the steel the stress which is received by the concrete.

Continuous bars extending through several stories and the prevalent fondness for weak mixtures seem incompatible with attaining the full efficiency of this method of reinforcement. The intensity of the stress above mentioned is such as to demand the use of substantial iron plates, above and below the reinforcing bars, at each column, for its proper distribution. Progressive stripping of the concrete from the steel would be expected to occur unless suitable provision is made to meet this intense stress, which would exist in the steel bars, if full advantage is taken of their resisting capacity.

Ordinary mixtures have sufficient strength to prevent the buckling of the steel bars, as compressive stresses advance. Rupture of a column is finally attended with the buckling of the reinforcement, but this takes place only over a short distance, other parts of the concrete, even at this stage, having strength enough to confine the buckling to one locality.

There are features to be considered, when referring to the final rupture of the concrete, in common with the buckling of the reinforcing bars and the portion of the total load then sustained by them. As rupture is approached the stresses rapidly increase on the steel, and incident to local disintegration of the concrete, the total stress on the concrete may really diminish while the total load on the column is still advancing.

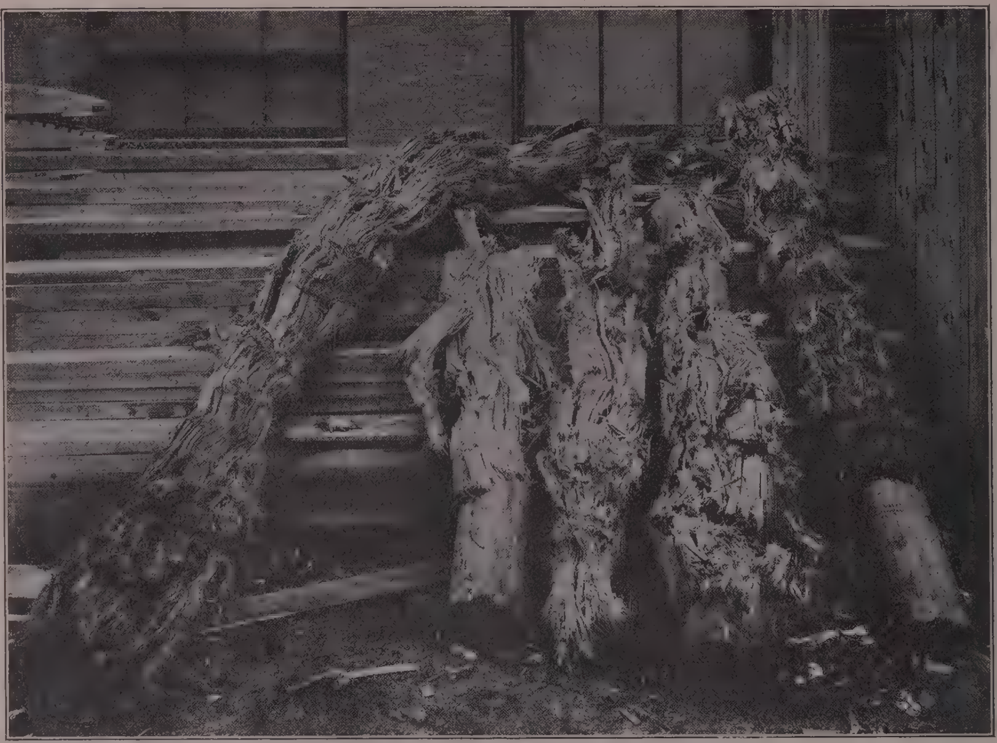
The ratio of stress per square inch on the steel bars to the concrete is a constantly varying one, at different loads in the same column; in the early stages of induration varying with the age of the concrete; after higher loads have been applied the ratio will be slightly different when lower loads are again applied, and the richness of the mixture also modifies this value. Ratios ranging from 2.8 to 33.3 are shown in the Watertown Arsenal tests of 1904, the lower values pertaining to early loads on rich mixtures, the higher ones to leaner mixtures and under stresses just prior to the ultimate rupture of the concrete. At a load of 600 lb. per square inch on the columns the ratios were generally from 6.4 to 12.3.

The influence of reinforcement on the durability of the concrete, whether done by hooping or by longitudinal bars, is an interesting question to speculate upon. Durability will be promoted by whatever means are employed to restrict the development of strains, and each method of reinforcement, in its way, tends to do this. In the method of external reinforcement by hooping, a certain direct compressive strain must precede or accompany the restraining action of the hoops. Practically they will not begin to act until there is substantial longitudinal compression of the column, whereby a resultant lateral expansion is caused. That is, a certain amount of distortion must take place before the hoops will offer material resistance, after which their aid will be more effective.

With longitudinal bars, embedded in the concrete and so arranged at their ends as to receive immediately a portion of the load, the durability of the concrete will be promoted by being relieved of a portion of the load and being less strained in consequence thereof. Working the concrete under diminished loads is, of course, favorable to its durability under long-continued stresses, and this is virtually the effect of longitudinal reinforcement.

Overdriven Piles.

The foundations for the Naval Engineering Building for the Massachusetts Institute of Technology at Park Square, Boston, are made with good spruce piles about 6 in. in diameter at the point and from 9 to 12 in. at the butt. They were driven by a 2,500-lb. drop hammer in soil which contained large quantities of boulders 10 ft. below the surface. They were driven in an ordinary manner without unusual difficulty or extremely numerous or heavy blows and no indication was observed that they were overdriven, until in later excavation it was discovered that a number of them were badly injured. Some of these were removed and photographed, presenting a badly crippled appearance shown in the accompanying illustration. The result of this demonstration induced the contractor, Mr. Frank B. Gilbreth, to devise a special type of reinforced concrete piles with corrugated surface which are cast before driving and are sunk chiefly by scouring with a hydraulic jet and by loading in the manner recently described in these columns.



Effect of Overdriving on Wooden Piles

About 300 wooden piles were driven for the Naval Engineering Building. Their length averaged 28 ft. and they were driven by blows of a maximum fall of 30 ft. and at a rate of about 36 piles in 10 hours by one machine. Separate records were not kept of the driving of the different piles and it was impossible to determine on their records after driving whether they had been damaged. The injuries noted were detected by displacement and instability and sometimes by injuries noted on the exterior of the piles where they were exposed in pits dug to depths of about 7 ft. for the purpose of cutting the ends off and placing the concrete around their tops. When suspicious indications were observed the excavation was continued farther and in ten cases where the piles appeared to be seriously injured or unsatisfactory they were withdrawn. None of them were shod and none of them were reinforced by driving bands or caps. Most of them were driven to a refusal of about 1 in. under a 15-ft. heavy blow of the hammer. They were calculated to sustain a maximum working load of 30,000 lb. each. A load now equal to this has been placed upon them by the construction of the building and they have carried it for about two years without any reports of settlement. The building was designed and constructed under the direction of Messrs. Rand & Skinner, architects, and Mr. F. B. Gilbreth was the contractor for the building and its foundations.

The Detroit River Tunnel.

The Detroit River tunnel of the New York Central lines, to connect Windsor, Ont., with Detroit, Mich., is sufficiently planned for contractors to be figuring on the work now, and their tenders will be opened March 8. The advisory board of engineers, which has charge of the engineering and award of contracts, consists of Messrs. W. J. Wilgus, vice-president New York Central & Hudson River R. R., chairman; H. A. Carson, of Boston, and W. S. Kinnear, of Detroit. The tunnel will have a length, including approaches, of 12,800 ft., made up as follows: West approach in tunnel, 2,135 ft.; sub-aqueous portion, 2,625 ft.; east approach in tunnel, 3,100 ft.; total length of tunnel, about 7,860 ft. West open approach, about 1,540 ft.; east open approach, about 3,400 ft.; total length of approaches, 4,940 ft. The grade in the tunnel on the Detroit side will be 2 per cent. and on the Windsor side 1½ per cent. The tunnel will be operated by electricity and bids for the electrical equipment will be called for about Feb. 15.

Sand-lime Bricks are continuing their growth in public favor in Germany, and in Berlin they have recently been employed in such important public works as an addition to the Moabit court house, several buildings for the War Office, and the new city hall.

Foundations and Underpinning in Mud and Sand.

The eight-story, 49½x102-ft. brick and steel building, at 230 West St., New York, is located very near the North River, and occupies the whole of a lot enclosed on three sides by old brick buildings with the footings of their adjacent walls carried down to a maximum of only a few feet below the curb. The ground water level is 7½ ft. below the curb and the soil to a distance of 22 ft. below that point consists of very soft wet mud overlying a stratum of hard, dense sand into which all foundations were carried about 1 ft.

The foundations for the new building consist of continuous concrete footings for the side walls and of two longitudinal rows of concrete piers 5½ ft. square. The tops of these piers are 8 in. below the cellar floor or about 12 ft. below curb level. They support brick piers 3 ft. square which extend through the basement and carry the column bases at curb level. The footings for the side walls are monolithic concrete walls 3 ft. thick and 18 ft. high. Their tops, like those of the piers, extend to the bottom of the basement floor concrete and are covered by the water proofing course of four-ply felt and tar which is carried under the floor and vertically up over the faces of the brick walls.

At the beginning of operations the walls of the old buildings adjacent to the long sides of the lot were supported on needlebeams so as to permit the old footings to be replaced by new ones carried down to the same level as those for the new building. On each side of the lot three pits were sheeted down to sub-grade 31 ft. below the curb and in them crib blocking was built up to support two lines of 14x14-in. horizontal timbers side by side about 7 ft. below the curb, parallel with and about 6 ft. in the clear from the adjacent wall. Holes were cut through the wall about 6 ft. apart on centers and through them were inserted horizontal transverse 12x12-in. needlebeams 2 deep, about 23 ft. long, supported at their outer ends on the longitudinal timbers above mentioned, and at their inner ends on a continuous 8x14-in. sill made of two courses of 4x14-in. breaking joints and laid on the floor parallel with the wall about 8 ft. from it in the clear. Both ends of the needlebeams were set on pairs of hickory wedges 2 in. thick at the butt and 12 in. long, which were driven until they developed solid bearing and nearly lifted the wall.

A full-length trench was then dug under the wall and carried down to a depth of about 30 ft., the sides being retained by 2 in. tongue and groove sheetpiling, driven in single lengths and bearing against rangers about 4 ft. apart. No great difficulty was experienced in driving this sheetpiling, but care was exercised to keep the lower ends below the deepest point of excavation. This precaution prevented settlement or shrinkage of material on the outside of trench.

On the south side, at a point about 10 ft. below curb level, a dense timber dock cribbing heavily ballasted with rock was encountered following down to nearly the full depth and length of the trench. Being adjacent to the river, considerable water was encountered and was removed by a 6-in. centrifugal pump.

As soon as the trench was carried about 1 ft. into the hard sand independent concrete footings, separated about 1 in. in the clear, were built for the old and the new walls. The work was commenced immediately after the trench attained the required depth and was carried on continuously until the concreting was finished. Connections between the new foundations and the under surface of the old brick walls were made in the usual way by steel wedges between pairs of 15x20-in. cut stones 4 in. thick and 20 in. apart in the clear which were seated on top of the footings.

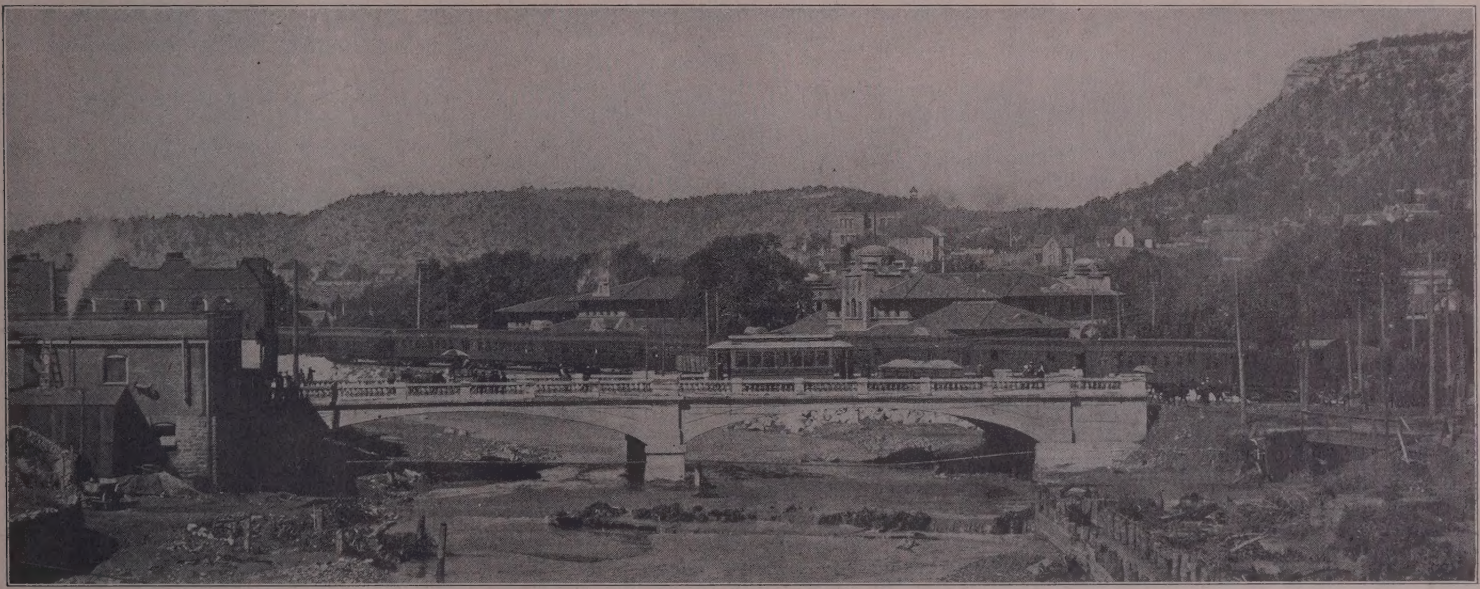
After the old walls were secured separate pits were sheeted down for the interior column piers, which were built in the ordinary manner, the pits being drained by 4-in. centrifugal pumps. The concrete was made 1:3:5 with Atlas Portland cement and was mixed by hand as required.

Miller, Daybill & Co., Brooklyn, were the contractors for the above described work, which was accomplished by an average force of 35 men in each of two shifts, which together worked 20 hours a day for about seven weeks under the supervision of Mr. Charles E. Holme, of that firm, Mr. C. L. Atkinson being directly in charge. Mr. J. W. Todd was the architect for the building and Messrs. Andrew J. Robinson & Co. the general contractors.

The Power Plant to operate the single-phase locomotives of the New York, New Haven & Hartford R. R. will consist of three 4,500-h.p. Westinghouse-Parsons turbo-generator outfits, 11,000 volts, 3,000 alternations, single and three-phase; two 125-kw. exciters, driven by Westinghouse steam engines; and a main switchboard upon which there will be mounted electrically-operated switches for 11,000 volts.

The Reinforced-Concrete Bridge at Trinidad, Col.

A reinforced-concrete bridge which will be subjected to exceedingly severe flood conditions was built during the past season over the Purgatorie River at Trinidad, Col. The Purgatorie River has its source in the Greenhorn Mountains, some 30 miles from Trinidad, and often carries a very sudden flood flow. Rainstorms over its drainage area above the bridge, although usually local, are often quite severe. The drainage area is rough and rocky country so that the percentage of run-off from it is large. After a heavy general storm over the upper portion of the watershed floods rush down all the streams and arroyos tributary to the river in heads varying from 2 to 10 ft. The river valley is narrow and has a fall of 30 ft. to the mile through Trinidad. These floods often reach the bridge site in a wave several feet high, which is generally covered with drift and moves at a great velocity. From the arrival of the first wave the river continues to rise rapidly, occasionally reaching 16 ft. above low water in a short time. In October, 1904, a rise of this character washed out two railroad and three highway bridges, and destroyed other property, including a brick hotel building, the passenger depot and several hundred feet of track of the Santa Fé R. R. in Trinidad.



View of Reinforced Concrete Bridge over Purgatorie River, Trinidad, Colo.

One of the highway bridges was replaced by a steel bridge and another by the concrete bridge which is to be described here. The site of the latter is at a narrow place in the river, with the railroad track on one side and business buildings on the other bank. The conditions of the site thus demanded a low grade and at the same time all of the available waterway was required. The bridge has two 70-ft. arch spans of the three-centered type, having a rise of 7 ft. It has a clear width of 64 ft. between parapets, made up of a 44-ft. roadway with a 10-ft. sidewalk on each side. The structure is designed to carry a live load of 125 lb. per square foot of roadway and walks, or 30-ton trolley cars on two tracks spaced 10 ft. on centers. The pier at the middle of the bridge is 7 ft. wide at the springing line of the arches, and the abutments are 27 ft. thick, making a total length, out to out of abutments, of 201 ft. The spandrel walls are, however, somewhat shorter. The south abutment extends back 20.5 ft. between a brick building on each side of the street carried by the bridge, which permitted the walls to be shortened that length at that end. Seven feet of the other abutment is on the right of way of the Santa Fé

R. R. and the spandrel walls were ended at the railway property line.

The arches are 14 in. thick at the crown and 3 ft. thick at the haunch and are reinforced with Thacher bars. Each arch has 44 pairs of longitudinal 1⅛-in. bars, the pairs being on 18-in. centers. One bar of each pair is near the intrados and the other near the extrados of the arch. The arches are also reinforced by 12 pairs of transverse ¾-in. Thacher bars. The pier and abutments are monolithic.

A hand railing consisting of a sectional balustrade having posts 11 ft. 4 in. on centers, with 9 concrete balusters spaced 12 in. on centers in the interval between each pair of posts, is placed on each parapet wall. The balusters are reinforced and were molded and well seasoned before being set in place. These railings add materially to the appearance of the bridge, as is shown in the accompanying illustration.

The bottom of the pier footing is 10 ft. wide and 19 ft. below the springing line of the arches, or 11 ft. below low water; the bottom of the abutments are 10 ft. below the latter level. The pier footing was built on 96 piles driven to refusal, while the abutment footings are each on 149 piles. In order to more directly resist the arch thrust 104 of the piles under each abutment were driven on a batter of 1 to 4.

The bridge was built on the silt bed of the stream, which is made up of materials washed down from the mountains. Many difficulties were encountered in making the excavations for the substructure. Below the silt in the bed of the stream is a coarse, cemented gravel, containing boulders up to 3 ft. in diameter. It was impossible to drive sheet piling through the material. Frames were built to hold the sheeting in place on the surface, and the sheeting was forced down as the excavation was made. This arrangement held the sides of excavation from caving but the water flowed into the holes as rapidly as a 10-in. submerged pipe driven by a 30-hp engine could remove it. An orange-peel dredge bucket was tried in the excavation without success, in an endeavor to avoid the pumping. Picks and shovels were found to be slow and expensive. The most successful method was to loosen the material by a hydraulic jet under 120 lb. pressure from the city water-works mains and then pump out the loosened material. The pump easily handled all gravel smaller than 4 in. in diameter; the larger stones were removed either by hand or with a derrick. The excavation inside the sheeting for each abutment was 30x70 ft. in plan and 14 ft. deep. This method of removing the loosened material was entirely successful in making all the excavations and had to be used a second time when a 6-ft. rise in the steam entirely filled the completed excavation for one abutment.

The concrete was made in a Smith mixer set at one end of the bridge, and hauled from the mixer to position in wheelbarrows. The concrete in the footings was made in the proportions of 1 of Portland cement, 3½ of sand and 7 of broken stone. That in the piers, abutments and spandrel walls was made, 1:3:6, and in the arch rings, 1:2:4. Iola Portland cement was used. The sand, which had to be obtained from the railroad company, was shipped 80 miles, considerable delay resulting from slow delivery. Quartz boulders from along the river were crushed and used for ballast.

Work on the bridge was commenced in the field about the middle of February, 1905, and despite the slow delivery of sand and several bad floods that occurred during the construction of the foundation, the bridge was opened to traffic Aug. 19, 1905. The Marsh Bridge Co., of Des Moines, Ia., Mr. J. B. Marsh, president, was the contractor. The engineering data needed during the construction were furnished by Mr. M. S. Hibbard, city engineer of Trinidad. Mr. John J. Dallison was the inspector of the work.

New Facts About Eye-Bars.

In the execution of the superstructure of the Quebec Bridge, with its 1,800-ft. channel span, the great magnitude of the members, the high working strains, and other features of the work have demanded careful study of many points, which, in ordinary bridges, could be and have been overlooked or neglected as of small importance. In a paper written by Mr. Theodore Cooper, which will come up for discussion at the meeting of the American Society of Civil Engineers on March 21, the new facts developed in regard to eye-bars are discussed in much detail. In August, 1904, the manufacture of the eye-bars for the anchor arms of the Quebec Bridge was well under way when the question arose as to what clearance should be allowed between the pins and pinholes. The eye-bars forming the tension members were 15 in. in width, from 1¼ to 2 1/16 in. in thickness, and of lengths from 50 to 58 ft. The pins, except in a few special cases, were 12 in. in diameter and from 8 to 10 ft. in length. The maximum joint has 58 bars on one pin. After discussion, it was decided that the clearance necessary for the purposes of erection should not be less than 1/32 nor more than 1/16 in., the latter being about the proportion given to ordinary bridge pins.

As the maximum working strains are higher than in usual practice, being about 21,000 lb. per square inch, in tension, the intensity and distribution of the local pressures from the pin to the eye of the bar became important. Mr. Cooper states in his paper (Proceedings Am. Soc. C. E., Vol. 32, P. 14), that after a little consideration of the problem, he realized that while the local pressure must be very great, and the pinholes must deform elliptically, at least elastically and probably permanently under the proposed working strains, the solution could only be obtained by experiment. He then devised a method of measuring the elongation of the bar from out to out of pins, while the bar was strained to varying amounts in the testing machine.

Four bars with different clearances were prepared and tested to 12,000, 16,000, 20,000, 24,000 and 28,000 lb. per square inch. While the result of these tests was not fully satisfactory, owing to the crudeness of the hurriedly made appliance, and the difficulty of reading the fine measurements in the limited space, they showed that the bars, from out to out of pins, began to elongate permanently at 12,000 lb., and that the elongation increased with each increase of strain. An examination of the results of tests of other eye-bars showed that the stretch of the eyes of eye-bars was not peculiar to the present "make" of bars, but had always occurred.

As it was important to push the construction of the work, it was decided to give the 12-in. pins 3/64 in. clearance, and, for the anchor arms then under construction, to add an extra allowance of 1/32 in. to the elastic elongation of each eye-bar for camber determinations; and should the further and fuller tests, then determined upon, show this to be too much or too little, the correction could be made in the cantilever arms.

Preparations were made for fuller tests, and, to eliminate the difficulties of the first method of measuring the stretch and also to get the action of each eye independently, the following method was adopted: Measure each bar from out to out of eyes, and calliper each eye longitudinally and transversely before putting it in the testing machine. Then, after straining the bar to 12,000, 16,000, 20,000, etc., lb. per square inch, remove it from the machine and repeat the measurements. In preparing the bars for test, it was determined to get from bars already made such a selection as would give a wide range in heat numbers, thicknesses, proportions of the head, and pin clearances. Some of the bars were specially bored to change the proportions of the head and the pin clearances, and two bars with visible flaws in the head were selected.

In addition to the previous observations, a number of the heads were scribed with fine lines, longitudinally and transversely, dividing the heads into spaces 2 in. square. After the rupture of the bars, these lines were traced and plotted, for comparison with the plots of the lines on the original bars, to determine the relative flow of the metal in different parts of the head.

As far as relates to the original purpose of the first tests, to determine the effect of the pin clearances, the tests give no definite answer. The different pin clearances vary from 0.031 to 0.084 in. While, no doubt, the pin clearance has some influence on the stretch of the eyes, it is hidden in the far greater influence of other factors. The eyes would undoubtedly elongate permanently were the pins fitted perfectly tight.

In like manner, the influence of the percentages of excess of the head is indeterminate. In these and other tests, however, there appears to be an influence due to the excess of material at the end of the eyes, which would indicate that for the best results this excess should be limited. The study of the tests leads Mr. Cooper to believe that a great stretch of the eyes before rupture, heretofore considered as showing a tough and tenacious material, is no more desirable than a tendency to buckle in front of the pin. It is thought probable that, for circular heads, 50 per cent. excess across the eyes, thus making the end section 75 per cent. of the bar, would be a favorable proportion.

Before the tests had gone very far, it was decided that the tensile strength should be advanced, the percentages of the heads increased, and the pin clearances for the bridge bars limited to 3/64 in.

While the pin clearances, excess of heads, tensile strength, and thickness of the bars, as affecting the tensile qualities, undoubtedly have some influence upon the stretch of the eyes, they do not give a full explanation.

The original bridge bars, being more than 50 ft. long, were cut in half and additional eyes made, so as to make two test bars. In one case, above mentioned, four test bars were made from one bridge bar. The bars first tested gave the worst results, presumptive evidence that more care had been taken for the later bars. The manufacturers and the inspectors assured Mr. Cooper, however, that no change had been made in any of the processes of the manufacture of the later bars. It was then decided to cut samples from the two worst heads and from one of the best, for nicked fractures and for tensile test, to see what the difference would be. These samples were examined, while fresh, by practical steel workers and experts. All agreed that they indicated nothing which would explain the different action of these heads.

Each class of bars tested in tension, after giving a steadily increasing stretch, up to a certain point for each class, then begins to yield more and more rapidly, the bars of the higher tensile strength, as a rule, and presumably the harder bars, resist this breaking down up to a higher point. The unequal pulling of the metal in different heads and in different parts of the same head shows that the metal is not homogeneous, but is softer in some bars and in different parts of the same bar. It is probable that the breaking down of the metal in front of the pin unequally is a large factor in the problem. It is undoubtedly a great mistake to seek a soft and ductile eye-bar by using either low tensile material or softening processes.

To get the best results, Mr. Cooper says, we must either use steel of a higher grade, or else stretch the eyes longitudinally, cold, before the final boring to exact length, or do both. He believes that, with proper appliances, eye-bars can be made which will not stretch in the eyes within the maximum working strains, without greatly increasing their cost.

Upon the development of the fact that eye-bars were not perfectly elastic even at low working strains and took an increasing permanent stretch with increasing loads, it became a grave question as to how a series of such bars will pull together. The permanent stretch, at any working strain, being independent of the length of the bar, while the elastic elongation is proportionate to the length of the bar, the difference of strain in two such bars will be less as the lengths of the bars are greater.

For bars of short lengths, under high working strains, the difference in strain becomes very great, which renders the use of such bars very undesirable. For much lower working strains and short bars, the bars will be subject to a like variation of strain, with long bars and the higher strains. It is very sure, therefore, that, when using high working strains, as are required for structures of great magnitude, long bars only must be used, if this stretch of the eyes cannot be overcome.

For the working strain of 21,000 lb. per square inch, it was found that a full set of bars of this kind would take a permanent elongation of about 1/16 in., or 1/32 in. for each eye, and this amount was provided for in all camber determinations. Further, it is thought that the probable error at the center of the channel span will not be more than 1½ in. either way, an amount of no importance.

Book Notes.

One of the most satisfactory discussions of the smoke problem that has yet appeared is Prof. J. L. Lewicki's "Bericht über Rauchfreie Dampfkessel-Anlagen in Sachsen." It gives the results of elaborate tests of sixteen boiler plants of nine different types, made with great care so as to secure comparable data. These tests were conducted on plants which were well-known as being free from smoke, and during the tests they were managed by the regular boiler room attendants in the usual manner, so that the results do not express anything but commercial every-day operation. Through the courtesy of the owners of the boilers it was possible to arrange the other conditions so that the results of the test could be used in comparison with the data obtained in other plants. The author was assisted in the work by Prof. Dr. Hempel, and the gas analyses and calorimetric work were done under the latter's supervision. Most of the furnaces tested are unlike those employed in the United States and for this reason the tests may seem of little direct applicability to American conditions. Nevertheless the concluding section of the report, in which the author analyzes the performance of the boilers in several ways, is very interesting and instructive. His introduction of a criterion for the utilization of the heat of the fuel is particularly imporant, while his diagrams for bringing out the work of the boilers when measured by different factors in their performance suggest methods of reporting the essential features of boiler operation which deserve careful study. The tests indicate that the efficiency generally decreases with the increased action of the heating surfaces; that, contrary to the usual assumption, a large excess of air is required for the formation of smoke; that the firing of the fuel and the regulation of the draft have a deep influence on the formation of smoke and the complete combustion of the fuel, and that really smokeless furnaces are little influenced by the rate of combustion per unit area of grate. (Leipzig, Arthur Felix, paper, quarto, 206 pp., 21 plates in album, 9 marks.)

Die Dampfturbine. By W. H. Eyermann. Munich, R. Oldenbourg; cloth, 8vo, 220 pp. 9 marks.

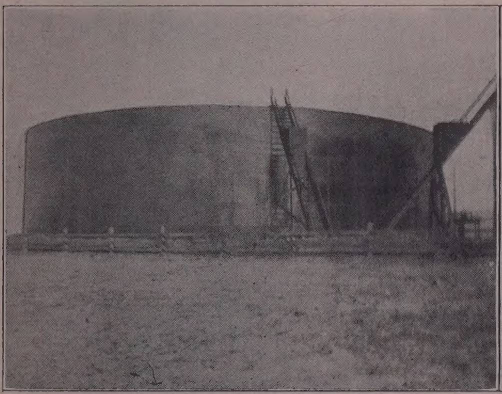
In the field of the steam turbine, the consciousness of certainty which comes only from the mastery of a subject is uncomfortably lacking as respects both general design and detailed computations. This necessary assurance of correctness can only be obtained when the new conceptions are associated in unbroken order and thus made readily comprehensible as a whole. The purpose of this book is to present the subject in this way. The author has accordingly considered it more desirable to state the scientific principles in a clear manner than to deduce by rigorous mathematical methods formulas whose applicability is often comprehended with difficulty. The really necessary formulas have been derived in an elementary way, in order not to lose sight of the assumption on which they are based and their accuracy, and their use is explained in all cases by well chosen examples.

While the theoretical discussion has been limited to the subjects absolutely necessary for an understanding of the physical principles, the descriptive, mathematical and critical treatment of the constructive elements of turbines has been given far more attention; and a large number of illustrations are employed to show the details selected for actual machines. Owing to the very comprehensive character of this information concerning detail design, the descriptions of different turbine systems can be summed up in a small space, and the volume accordingly has none of the trade-catalogue appearance which is inevitable with any other arrangement of contents. For the assistance of the designer the author gives a number of diagrams which have proved helpful in practical work. For example, the relations between diameter, number of revolutions and peripheral velocity, and those between diameter, number of revolutions and centrifugal force are represented in this way. To determine the factors necessary for ascertaining the velocity of steam flow and the size of steam passages, particularly jets and blades, a diagram of the properties of steam, based on the experiments of Prof. Mollier, has been so prepared that the steps between the data are shortest within the range of the most frequently employed temperatures. A special scale is provided for the direct determination of the theoretical steam consumption for any given fall in pressure. The use of the diagrams is illustrated by many solved problems, and their convenience is so great that they have been published in separate form, on special paper and with the scale on transparent celluloid. The volume closes with a list of the most important German patents for steam turbines.

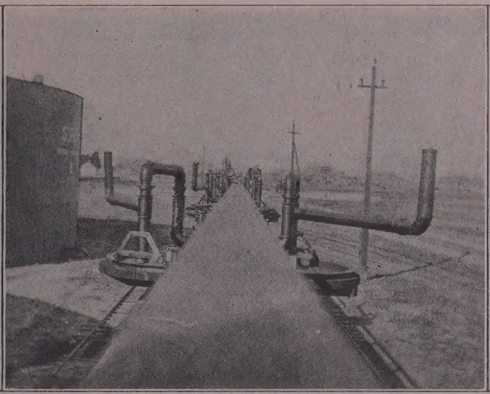
Letters to the Editor.

Oil Pumping in California.

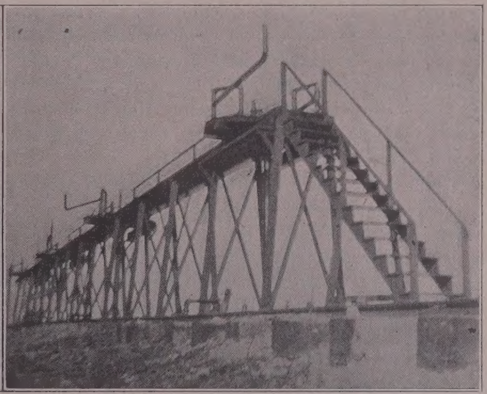
Sir: There are several good-sized oil pumping plants in the vicinity of San Francisco, the most up-to-date being at Melrose, a few miles east of Oakland, on a spur from the main line of the Southern Pacific R. R. It is used as a central storage and distribution station, from which oil is distributed to all parts of the State north of San Francisco and as far south as San Luis Obispo, half-way between San Francisco and Los Angeles. The total storage capacity of the plant is 330,000 barrels, divided among six tanks, each of 115 ft. diameter and 30 ft. high, with a conical-shaped roof having a pitch of about 4 ft. from center to periphery of the tank. The shell is composed of six 5-ft. sheets, the lowest ⅝ in. and the top ⅜ in. thick, all joints being single-riveted. The discharge and suction pipe enters the bottom of the tank and terminates in a swing pipe which can be raised or lowered by means of a winding drum on top of the tank, thus always obtaining the cleanest oil and preventing the loss of oil if anything should happen to go wrong with the piping immediately on the outside of the tank. In such a case the swing piping would merely be raised up above the level of the oil in the tank.



One of the Tanks



Piping on Top of Trestle.



Trestle Between Tracks.

Tanks are placed on top of the ground on foundations of gravel and imbedded rails. A depth gauge is provided on the outside, connecting on the inside with a ball float; this gauge, of the plumb bob type, is not used for accurate measurements. The inlet to the tanks is at the bottom of the tank through a 6-in. pipe fitted with a gate valve. The 6-in. pipes are connected with a 6-in. header into which the discharge line from the pump enters; this same piping is used for suction when filling oil cars for distribution. Alongside the tanks are two spur tracks with a long header between them. Between the rails of each track are pits about 6 ft. long, 3 ft. wide and 30 in. deep. These act as receiving pits to prevent losing oil in case the valve at the oil inlet of the car is found open on removing the cap; this frequently happens as the valves may get wedged open by sticks or other refuse getting under the valve seat when filling the car. On account of the small size of this pit it is connected through a 5-in. pipe line to a sump. Ordinarily the suction branches from the header between the tracks are screwed to the outlets of the cars, from which the pump draws its suction. The header is 12 in. at the point farthest from the pump house, reducing to 10 in. and then to 8 in. The oil cars are of an average capacity of 13,000 gal., although sometimes there are cars of as small a capacity as 6,500 gal.

The suction header between the tracks runs in an enclosed box about 18 in. deep, into which the pump exhausts its steam, thus heating the oil in the line. Directly over the branch to each car is a 6-in. riser running up about 15 ft., from which run car branches similar to the lower ones; these elevated pipes are used for filling the oil cars from the tanks for distribution. By the use of swivel joints the branches from the risers are made very flexible and have a long range of travel. The general view of the trestle work for the support of the filling pipes is shown in one of the illustrations.

The pump house, 15x25x12 ft. high, of wooden frame construction, with corrugated-iron roof and siding, is located about 150 ft. from the farthest end of the header. It contains a fire-tube boiler fitted with an injector, and a 10x12x12-in. pump having an 8-in. suction and 6-in. discharge; the boiler is fitted with an oil burner requiring small pressure for its operation, the atomization being by means of steam.

With an outside temperature of 85° and 14 gravity oil, eight cars can be emptied in less than three hours; the total number of cars emptied per day of ten hours is twenty-four. When the temperature is lower it requires considerable longer time; in some locations where the temperature is considerable lower than it is at Melrose it may take eighteen to twenty-four hours to empty eight cars, unless they are fitted with steam heating piping.

When doing this work the pump is operating at 95 strokes per minute with no trouble whatever. When drawing from tanks, however, it is necessary to slow down to 65 strokes per minute on account of the small 6-in. pipe which has now become the suction pipe. The amount of water consumed by the boiler in a ten-hour run averages about 70 gal. The fires are put out between the different periods of unloading and the engineer is advised considerable time before the arrival of an oil train, giving him time to get the plant in operation. There is no oil feed pump used in this plant, the oil being fed by gravity from a small supply tank placed 8 or 10 ft. above the burner; it would be preferable, however, to have a feed pump so that a greater pressure could be obtained at the burner tip. Yours truly,

San Francisco, Feb. 1. Bayard Burnite.

Flood Frequency and Characteristics in the United States.

Sir: Each year flood data are becoming of greater interest to the people who live along the streams, to the general public and to engineers. They are indispensable to the engineer who designs dams and must provide ample spillway for the largest flood; to the bridge engineer who must construct bridges economically and in such manner that they do not obstruct the flow of the stream; to the city engineer who must provide ample stream waterway and properly protect the banks from erosion; to the county or State engineer who provides suitable protection of low lands from overflow, and to railway companies whose property may be damaged or traffic suspended.

Data are in demand upon the following phases of flood phenomena: The magnitude both as to stage and daily rate of flow; the frequency or the number of times floods of a given magnitude occur in a given period; the time of occurrence, whether always in the spring or at irregular intervals; the duration, whether for a few days or for two or more weeks, and the rate of rise, whether rapid, leaving little time for the removal of goods from the area subject to overflow, or the reverse. To meet in a measure this increasing demand for data on flood flow a study has recently been made of all the available records of stage and discharge of thirty streams on which flood records have been kept for periods ranging from 11 to 119 years, and the daily rate of flow during the larger floods has been computed. The results of this study will appear in the Water Supply Paper on "Destructive floods in the U. S. in 1905." The data in the following table, used with permission of the director of the U. S. Geological Survey, throw light on the frequency and some of the characteristics of floods of various sizes.

The accompanying table gives the drainage area in square miles of each stream above the place of measurement, the length of record, or number of years that flood observations have been taken, the largest daily rate of flow during that period, the largest range of stage during the period of observation, the number of times that floods of a given magnitude, compared with the largest flood, have occurred in the period covered. This comparison of magnitude is by rate of flow, not by stage, except in a few cases.

Data on Flood Flow of Streams in the United States.

Stream.	Place.	Drainage area sq. miles.	Length of record, years.	Period.	Max. daily rate, *e*, sec. ft.	Range of stage ft.	Number of occurrences of ratio of greatest rate of flow.			
							.6 to .7	.7 to .8	.8 to .9	.9 to 10
1. Kennebec	Waterville, Me.	4,380	12	1893-04	25.4	...	3	2	0	1
2. Androscoggin	Rumford Fall, Me.	2,320	12	1893-04	23.8	...	1	1	0	1
3. Merrimac	Lawrence, Mass.	4,553	59	1846-04	18.0	...	..	..	1	3
4. Connecticut	Hartford, Conn.	10,234	105	1801-05	20.0	...	..	..	7	2
5. Hudson	Mechanicville, N. Y.	4,500	35	1869-03	15.6	...	..	..	1	1
6. Genesee	Rochester, N. Y.	2,428	119	1785-03	19 to 22	...	..	..	1	1
7. Passaic	Dundee, N. J.	8,227	26	1877-03	42.5	...	...	1	0	1
8. Raritan	Bound Brook, N. J.	806	96	1810-05	64.5	...	..	2?	1?	1
9. Delaware	Lambertville, Pa.	6,855	120	1786-05	37.1	...	..	0	2	1
10. Potomac	Point of Rocks, Md.	9,650	17	1889-05	48.9	...	0	0	0	1
11. Susquehanna	Harrisburg, Pa.	24,030	17	1889-05	28 to 30.6	...	..	1	0	2
12. Cape Fear *a*	Fayetteville, N. C.	3,860	15	1889-03	18 to 23	57.8	13*a*	17*a*	7*a*	2*a*
13. Savannah	Augusta, Ga.	7,500	66	1876-05	40.0	36.8	39*a*	31*a*	10*a*	2*a*
14. Alabama	Selma, Ala.	15.400	14	1891-04	9.5	58.9	6*a*	10*a*	6*a*	3*a*
15. Black Warrior	Tuscaloosa, Ala.	4,900	17	1889-05	32.0	64.8	10*a*	11*a*	12*a*	8*a*
16. Monongahela	Lock No. 4, Pa.	5,430	20	1886-05	38.1	38.8	3	1	0	1
17. Youghiogheny	Confluence, Pa.	782	32	1874*b*-05	53.8 to 59.0	17.8	6	1	0	1
18. Allegheny	Freeport, Pa.	9,220	31	1874*c*-04	26.7*d*	37.5	65*a*	17*a*	7*a*	4*a*
19. Ohio	Wheeling, W. Va.	22,600	22	84-05	21.5	53.4	3	5	1	1
20. Tennessee	Chattanooga, Tenn.	21,382	38	67-04	34.4	58.0	..	0	0	1
21. Illinois	Peoria, Ill.	15,700	16	91-05	3.3	19.3	..	2	2	3
22. Mississippi	St. Paul, Minn.	36,085	38	67-04	3.3	19.0	..	..	..	3
23. Kansas	Lawrence, Kan.	59,841	25	81-05	3.8	27.5	0	0	0	1
24. Rio Grande	San Marcial, N. M.	28,067	11	95-05	1.17	...	1	0	1	1
25. Colorado	Austin, Tex.	37,000	9	96-04	3.33	...	0	1	0	1
26. Loup	Columbus, Neb.	13,540	10	95-04	5.17	...	0	0	0	1
27. Arkansas	Pueblo, Col.	4,600	10	95-04	2.40	...	1	1	0	1
28. Bear	Collison, Utah	6,000	15	90-04	1.76	...	3	2	0	1

a Number of occurrences of—magnitude of greatest stage. *b* Two years' records not complete. *c* Three months' of 1888 record missing. *d* Maximum daily rate at Kittanning during March, 1905, flood. *e* The rate for a part of a day may be several per cent. greater than the maximum daily rate.

The rate of flow per foot increase of stage is much greater for the higher stages than the lower ones, so that the frequency of the stage from, say, eight to nine-tenths of the maximum stage is much greater than the frequency of the rate of flow of from eight to nine-tenths of the maximum rate of flow.

Streams in certain sections have flood characteristics quite different from those in other sections. Streams Nos. 1 to 6 in the above table form a northern group. The larger floods on these streams all occur in the spring. They are due to the rapid melting of snow, intensified at times by the formation of ice gorges. The depth of snow on the ground in the early spring and the rate at which it melts are the controlling flood factors. Floods due to rain alone are about half the magnitude of the spring floods, and are of much shorter duration. The maximum rate of run-off of these streams is small (15 to 25 second-feet per square mile) compared with streams of the same size of basin and depth of annual precipitation elsewhere. Floods of the first or second magnitude (from eight to nine-tenths and from nine-tenths to the entire magnitude of the greatest recorded flood) may be expected to occur on the average once in 12 to 25 years.

Streams Nos. 7 to 11 form a second group. The rate of flood flow is larger than in group 1 and some of the large floods are due to melting snow, and some entirely to rain. The summer floods are not of as long duration as the spring floods. Large floods are not as frequent as in group 1, occurring about once in 20 to 50 years.

The length of record of the four southeastern streams (Nos. 12-15) is too short, except possibly that of the Savannah, to include the largest flood. The range of stage is large, and on account of the sluggish flow floods occur more frequently and last longer. The largest flood occurred in the fall, and had a rate of flow somewhat less than the largest rate of flow in group 2.

The largest floods in the Upper Ohio basin (Nos. 16-19) occur in the spring; two exceptions are the flood of July, 1888, on the Monongahela, and that of August, 1888, on the Youghiogheny. They resemble somewhat those of groups 1 and 2, but are more like group 1. Illinois and Upper Ohio Rivers have a remarkably small rate of flood flow, less than 3⅓ second-feet per square mile. The large floods occur in the spring. The largest flood on Grand River, Michigan, in probably a century had a maximum daily rate of about eight second-feet per square mile of drainage area.

Streams 23-28 are in the arid and semi-arid regions and their rate of flood flow is very small. Very large floods rarely occur on these streams and are due to heavy rain. Ordinary floods generally occur in the spring, and are due to melting snow; an exception to this rule is Kansas River. The two great floods on Kansas River were about sixty years apart.

Very respectfully, E. C. Murphy.
Washington, Feb. 3.

A Method of Railway Braking has been devised which permits different braking powers on freight cars for use when loaded or light. The system, known as the Sauvage safety brake, is applicable to the standard Westinghouse or New York car equipments by using an additional brake cylinder, and its efficacy is secured by greatly delaying the maximum pressure. Recent tests indicate that much safer stops may thus be made, with no skidding of wheels.